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## PROBLEMS OF UNIVERSITY EXPANSION IN BRITAIN

DESPITE the general interest of the report of the University Grants Committee as a record of university development in Great Britain during 1935–47 (see p. 154 of this issue), and the picture it gives of the very considerable achievements of British universities both before and during the War, that part of the report which deals with post-war developments and problems is likely to receive most attention. None the less, the greatly increased scope of the activities of the University Grants Committee, to which the whole report bears witness, make it desirable that the early chapters should be read by a much wider public than those who may be immediately affected by the developments or special problems discussed later in the report. The scale on which the universities of Great Britain are now being assisted from national funds makes it imperative that the ordinary citizen should have a clear idea of how those funds are being spent and what the nation is receiving in return. Within its limits the report makes a valuable contribution to that end; but it may well be held that an increasingly important function of the University Grants Committee in the future will be the interpretation, to the nation as well as to the Government, of the policies and the financial needs of the universities.

The two most impressive features of the present report are its revelation of the extent to which the expansion of the universities urged from many quarters during the War has already taken place, and the confidence of the Committee that the increasing dependence of the universities on State assistance and the central planning of university development so as best to promote the public welfare, at least on the lines indicated in the report, need not endanger academic autonomy. Already the number of students has risen from the pre-war 50,000 to some 77,000 as against the 88,000 which, ignoring financial considerations, the universities had estimated they would be able to deal with at the end of ten years. This latter estimate is only 2,000 short of the total recommended by the Barlow Committee; and analysis of the figures by faculties indicates that in science and technology the pre-war numbers have already been doubled. Numbers in the faculties of arts, however, have risen by only about 50 per cent, although accommodation for arts students is not in general so limited as for science and technology, and in the arts faculties a higher proportion of applicants gains admission. The University Grants Committee, however, advances sound reasons for its doubts whether the arts faculties are likely in the remainder of the decade to expand by the 10,000 students required to achieve the proposed doubling of numbers in all faculties other than medicine.

The University Grants Committee is not unduly disturbed by the probability that for some years to come the proportion of students engaged in scientific and technological studies is likely to be higher than it was before the War. It points out that the pro-

portions of students in these faculties have varied greatly in different universities, and that what is vital is that in each university the several disciplines should be represented in such proportions that members of the various faculties are brought into contact with students in other fields. Such contact becomes more difficult if the proportion of any one faculty is excessively low or high, and the University Grants Committee suggests that the proportion of arts students should not fall below one-third. It may well be, as suggested, a matter for examination whether the different ratios which have been temporarily established in the total student population in Great Britain during the post-war years represent what is desirable from the national point of view, and also whether it should remain constant. Much more important is the maintenance of quality, of conditions which make possible the effective mingling of the faculties and a proper relation between the number of students in the different faculties and their prospects of employment. These are the factors with which the University Grants Committee is concerned, and it is rightly insisted that the rate at which university expansion can wisely proceed must take full account of all three.

The question of quality naturally involves that of selection, and the Committee's observations on this point are appropriately considered in discussing the recommendations of the 'working party' on university awards (see *Nature*, January 22, p. 113). Next to the quality of the students, however, the maintenance of university standards depends on the quality of the life and education which the universities are able to offer. The University Grants Committee is very seriously concerned with the heavy strains which the rapid expansion has imposed on staff and students alike, and the consequent serious deterioration in the standards of university life. It rightly observes that conditions which may be tolerable for a short period become in time unendurable, and, while less cautious or pessimistic than the Nuffield College Committee in its recent statement, is convinced that unless additional accommodation can be speedily provided, the present numbers of students cannot be maintained without grave risk of impairing academic standards.

On these grounds, it is apparent that if the provision of the additional accommodation so urgently needed in the form of new teaching blocks, halls of residence, libraries and central amenities is not forthcoming when the present considerable proportion of ex-Service men declines, the Committee believes that the universities will be well advised to delay filling their places with younger undergraduates. Maintenance of the present overcrowded conditions with a less mature body of students involves the danger that the really outstanding people will be unable to reach the standards which were attained before the War. The view that provision of a leisured university life, with adequate opportunities for regular contacts between staff and students, should come before any expansion in numbers which denies such opportunities is supported by observations both from the point of view of graduate employment and of the expansion and conditions of the university staffs.

Although university education should not be regarded merely as a means of training for particular careers, some attention, as we have repeatedly urged, must be paid to the rate of expansion in the output from different faculties. While it is important that, besides equipping scientific workers, technologists and medical men for their work, the universities should provide men and women of trained intelligence and wide culture for the solution of social problems, the administration of public affairs and the enrichment of every sphere of human activity, a sense of frustration and disillusionment would be created if many graduates were unemployed, or employed in occupations which made no real or satisfying use of their abilities. It is clearly easier to estimate the future demand for graduates in science and technology; but even here, though much valuable work has been done, the survey is at present far from complete. On the imperfect data available, no more general inference is warranted than that although some adjustment of numbers as between different branches of science and technology may be required, no considerable increase in the present total of such students will be demanded in the foreseeable future.

On the other hand, the future demand for arts graduates is extremely problematic. Despite the reasonable contention that larger numbers of graduates in arts could be employed with advantage to the nation in local government administration, in industry and in commerce, the prospects of any rapid increase in any such openings are hazy. A changed mental attitude is required on the part of graduates, no less than on the part of local authorities and other employers. It is not easy even to estimate the number of recruits for the administrative class of the Civil Service who would be recruited from arts as distinct from science graduates. The University Grants Committee believes that the university appointments boards could make an important contribution; but in the meantime, firmly as it believes that it is essential for our national well-being that means should be devised to permit the recruitment into non-technical employment in industry of a steadily increasing proportion of university men and women, the Committee is right to utter the warning that the present numbers of arts students cannot be maintained or increased without the danger of creating unemployment, unless the avenues for employment are greatly widened.

That in itself may enforce early reconsideration of the balance of studies, as the Committee itself admits. Moreover, if the ratio between the faculties is to be changed without detriment to university standards, regard should be had to the content of the curriculum, especially perhaps so as to correct any tendency to narrowness of outlook on the side of science and technology, as well as to the means of ensuring contact between the students of different faculties, on which the University Grants Committee rightly lays considerable stress. It goes far, indeed, towards commending the suggestion which Sir George Arthur made in the foundation oration at Birkbeck College

on March 28, 1946, that in every department one lecture should be given, or one paper read, every week or every month, by a student in another department, so that, by the time he took his degree, every student should know what the whole college was doing and have had some experience of the difficulty of conveying, in the language of common discourse, ideas familiar to us in the language of special discourse or technical terms. Humanists would learn how to make the language richer and more precise by the accurate use of scientific terms, and scientific men might discover that the King's English is a far more adequate medium even for conveying scientific ideas than they had hitherto supposed.

It is an important contribution to the discharge of the function of a university to see that every student knows something of what the university as a whole is doing and to keep the channels of communication between one mind and another open, and bright and clear; and it must profoundly influence the prospects of graduate employment as well as their employability. But its discharge depends in turn very largely on those questions of academic staff which are causing such serious concern to the University Grants Committee in regard to the maintenance of university standards.

The recruitment of academic staff in sufficient numbers to enable the universities to deal with their wider responsibilities is regarded as one of the most difficult problems confronting them. Apart from the increase in the number of students, there is a general desire to increase the ratio of staff to students, while a third reason for increasing the academic staff is the introduction of new subjects which call for the services of specialized teachers and research workers. No accurate measure has been obtained of the increase in full-time staff which would be required to meet these needs. At a rough guess, the University Grants Committee puts the total of full-time staff required at 10,000 as against a pre-war 4,000, assuming that student expansion on the scale contemplated is achieved by the end of the decennium; but it estimates 8,000 as the maximum that could be expected by the end of the quinquennium, without any firm confidence that this expectation will be realized. It points out that the suspension of normal university activities during the six years of war has left a gap in the production of men and women suitable for appointment as university teachers which will take years to repair. During the war years, moreover, many senior teachers remained at their posts after the normal age of retirement, while many other posts remained unfilled.

Temporarily, there is a demand much in excess of the supply of suitable candidates, and even if there is no further increase in the numbers of students, no marked improvement in the staff–student ratio appears likely during the present quinquennium. The present age-structure of the university staffs in Britain constitutes a further reason for caution. To-day, some fifty per cent are less than thirty-five years of age, and the University Grants Committee suggests that while the Universities may be able to do little to remove the disproportion, they should attempt to plan future recruitment so as to secure a more uniform distribution over the ages from twenty-five to sixty-five. Furthermore, the reinforcement of staffs is dependent on the physical expansion of the universities, so as to provide conditions in which the staff are no longer handicapped by unsatisfactory environment.

There is no suggestion in the report that the heavy strain under which university staffs in Britain have been working during the last ten years has hindered recruitment; and the University Grants Committee appears to be confident that the marked improvements in the salaries of lecturers are adequate to attract a sufficient flow of candidates of the right type, though it points out that any substantial change in the value of money or in the standard of remuneration in comparable professions would lead to a situation requiring consideration of salary-levels. It lays more stress on the importance of associating the lecturer grades with the administrative work of the University, and of providing the senior members of the staff with secretarial or administrative assistance and with adequate technical assistance in the laboratory. Such means of relieving the senior members of duties which do not demand their personal attention are particularly important while it is difficult to obtain staff of sufficient seniority, and also to enable the universities to continue to give assistance in the development of university institutions in the Colonial territories that is being planned.

This sober review of university development is thus full of encouragement. Like the Nuffield College statement, it hints at the possibility that expansion may have to be re-timed, and that the rate of expansion may need to be modified. But the wide vision and the balance of the report warrant every confidence that the University Grants Committee will prove equal to its new and wider responsibilities, and that the expansion of the universities of Britain will be guided wisely and imaginatively. The Committee clearly intends that academic autonomy and standards shall not be impaired, and that the new opportunities of service to the community should be fully utilized. The contribution of the universities over the whole field of national life can repay increasingly those large appropriations for their support which are now made from the national exchequer.

## VITAMINS AND HORMONES

### Vitamins and Hormones

Advances in Research and Applications. Vol. 5. Edited by Prof. Robert S. Harris and Prof. Kenneth V. Thimann. Pp. xvi+478. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1947.) 7.50 dollars.

THE volume under consideration deals with many aspects of vitamins and hormones, and it will certainly be of the very greatest value to anyone involved in research in these particular fields, or who is teaching or preparing a text-book.

The first section, by Nicholas A. Milas, deals with the synthesis of vitamin A and related products. The

bibliography is complete up to well into 1947. The article deals very thoroughly with the production of synthetic analogues, and a particularly clear account is given of the work on synthesis by Heilbron and his colleagues, and the relation of this work to that published by the Dutch investigators, Van Dorp and Arens.

It is not possible to review in detail all the sections, and passing over the very full and excellent account by Melnick and Oser of the physiological availability of the vitamins and Von Muralt's summary of the present position of vitamin $B_1$ in relation to peripheral neurophysiology, we come to William J. Darby's review of the position of pteroylglutamates in relation to human nutrition and disease. Workers in Great Britain and on the Continent of Europe have failed to realize the enormous concentration that has taken place in the United States on this work. Investigation of the extensive metabolic and hæmatological effects of folic acid constitutes only one small part of the work. Very extensive investigations have been made into the effect of folic acid in sprue, chronic diarrhœa, and various diseases of infancy and childhood. This summary will go a long way to prepare the British and Continental reader for the vast amount of work that will be published from now onwards in the journals of the United States. Efficient and excellent as this article is, it can only act as an introduction to this subject, since important questions, such as the anti-folic acid substances and their use in various conditions like leukæmia and in the treatment of malignant disease, are not touched upon.

Then follows a short chapter by H. R. Bird on the vitamin requirements of chicks. It is pointed out that this is important not only in the study of nutrition as a whole but also for "the more efficient and profitable production of this economically important animal". A rather longer chapter, by H. P. Morris, deals with the vitamin requirements of the mouse.

Choh Hao Li and H. M. Evans deal very thoroughly with the properties of the growth and adrenocorticotropic hormones. The methods of assay and of isolation, and the physical, chemical and biological properties of these two hormones are described. Then follows an article by C. W. Emmens and A. S. Parkes on the effect of exogenous œstrogens on the male mammal. This is very valuable in that it collects together the much scattered work on the effect of œstrogens on such varied functions as growth and sex differentiation and on other glands.

The chapter on the biology of antithyroid agents by H. A. Charipper and A. S. Gordon deals very exhaustively with the effects of thiourea and its derivatives on the structure of the thyroid and pituitary glands in various species, on growth and general metabolism, on iodine metabolism, on enzyme systems, etc. The article also deals with the chemical nature of the antithyroid agents and their clinical applications.

The next chapter, on the use of androgens in women, by Anne C. Carter, E. J. Cohen and E. Shorr, describes the biological effects of androgens in women and their use in the treatment of various disorders.

The final article, by C. G. Heller and W. O. Maddock, deals with the clinical uses of testosterone in the male. The authors indicate the various ways in which hypogonadism can be diagnosed. They indicate the various methods of administration of testosterone, its biological effects and its clinical applications.

E. C. Dodds

## MORE BESSEL FUNCTIONS

**Tables of the Bessel Functions of the First Kind of Orders Ten, Eleven and Twelve**
Pp. x+636.

**Tables of the Bessel Functions of the First Kind of Orders Thirteen, Fourteen and Fifteen**
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Pp. xi+764.

**Tables of the Bessel Functions of the First Kind of Orders Twenty-eight through Thirty-nine**
Pp. ix+694.

By the Staff of the Computation Laboratory. (Annals of the Computation Laboratory of Harvard University, Vols. 7, 8, 9 and 10.) (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1948.) 55*s*. net each volume.

THESE four massive volumes contain a further very substantial instalment of the publication of the great table of the Bessel function $J_n(x)$, for values of $x$ less than 100 and for integer orders $n$ up to 100, which has been computed by means of the automatic sequence controlled calculator in the Computational Laboratory of Harvard University under the direction of Prof. H. Aiken. Previous volumes have been reviewed in these columns (*Nature*, **160**, 773; 1947), and five further volumes will be required to complete the project.

It will be noted that while volumes 7 and 8 (like their immediate predecessors) contain only three functions, volumes 9 and 10 each contain twelve. This is made possible by discontinuing the tabulation of values at intervals 0·001 in $x$ for values of $x$ less than 25, for orders above the fifteenth, and thereafter using a uniform interval 0·01. This will reduce to about three feet the present writer's earlier estimate of the length of bookshelf required to house the complete series. Except perhaps for the smaller values of $x$ (where 10 decimals mean fewer than ten significant figures), it is unlikely that many users will often find inadequate the values within their range which the tables actually give; indeed, the provision is on a munificent scale.

Since the previous review was written, a systematic comparison has been made of values common to the Harvard tables and the tables, now in proof, to be published as "British Association Mathematical Tables", Vol. 10, and no error has been found in the Harvard tables.

In reviewing these volumes one cannot help contrasting the resources enjoyed by our American colleagues with those which have been at the disposal of workers in the same field on the eastern side of the Atlantic. But there is a danger that lavish resources may be wastefully used. The terms of the power series for $J_n(x)$ are numerically the same as those for $I_n(x)$, and an almost similar remark applies to the asymptotic series, including those for $Y_n(x)$ and $K_n(x)$, so that with slight modifications in procedure, and without proportional increase in time or labour, fundamental values for the other three functions over considerable ranges could conceivably have been produced concurrently with those for $J_n(x)$. However, let us be thankful for great mercies!

W. G. Bickley

# A TEXT-BOOK FOR AGRICULTURAL ECONOMISTS

## Farm Management

By Prof. John D. Black, Marion Clawson, Charles R. Sayre and Walter W. Wilcox. Pp. xii + 1073 + 62 plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1947.) 27*s.* 6*d.* net.

FARM management as a subject of serious economic study has derived a great deal of stimulus from the United States, especially since the 'country-life movement' was set on foot there some forty years ago. The early workers in that field set out to study the whole social structure of the countryside; but a large part of their attention was necessarily directed to the purely business aspect of farming, and indeed the study of farm management has been in danger all too often of being regarded merely as a means of helping the individual farmer to make more profit. Anyone who is at all familiar with Prof. John D. Black's work on production economics, however, has learnt to expect a more comprehensive outlook, and in this imposing volume that expectation is not disappointed.

Apart from the four main parts of the book which deal, in no fewer than nine hundred pages, with systems of farming, principles and methods of analysis, problems of management, and management of types of farming, there are an introduction and a finale with chapters on such topics as the ends of farming, farming in a changing world, and agriculture in the national economy. These bear on the broader problems concerned with reconciling the interests of farmers with those of society as a whole, and embody much of the practical wisdom accumulated over many years by Prof. Black and his distinguished collaborators.

The student is made to see that modern agriculture does not stand in isolation, and that the management of a farm, if it is to be successful in the long run, should look beyond the immediate profit-and-loss account. This emphasis is to be welcomed in general, though some readers may consider, in this instance, that breadth has been secured at some sacrifice of depth. Certainly the British student, dependent as he largely is on American texts for the application of economic principles to farm management, will find the mass of descriptive material a little distracting, the more so as it relates almost entirely to American conditions. It is also unfortunate that some references to conditions in Great Britain are inconsistent and inaccurate. For example, it appears that if leasing arrangements such as prevail in England and Wales could be developed in the United States, there would be no serious objection to a large increase in tenancy in that country (p. 654); but this is a conclusion scarcely to be expected, perhaps, in view of the statement that in England "the landlord does practically nothing except to receive his rent and occasionally give his consent to having some new buildings or other improvements put on his farm, or possibly to having some timber cut" (p. 13).

Blemishes of this kind—there are a few others—are relatively unimportant against the authors' competent handling of their main project, which is to provide and expound methods for analysing the problems that develop on farms of varying complexity, and the principles which may be evoked for their solution. It is this aspect of the book, rather than the illustrative material, which will be found helpful and which deserves most attention, at any rate in Great Britain.

R. N. DIXEY

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# THOMAS ALVA EDISON

## The Diary and Sundry Observations of Thomas Alva Edison

Edited by Dagobert D. Runes. Pp. xii+247+5 plates. (New York: Philosophical Library, Inc., 1948.) 4.75 dollars.

DRIVEN by his deafness to read his way through the Detroit Public Library, Edison wrote long afterwards that he had found that almost any book would supply entertainment or instruction. This book, which contains selected excerpts from his writings, supplies the first in good measure and, for those who reflect on reading, more than a modicum of the second.

The pages from the diary which form the opening section of the book are full of whimsical humour which one would not have expected from a prodding experimenter who died with more than a thousand inventions to his credit. There is little reference in the book to Edison's experimental work, except for a short account of his early struggles to make a motion picture machine, carried out in a studio irreverently called the "Black Maria". But the background is there, revealed in the words that experiments in a laboratory consist mostly in finding out that something will not work. A realization of this, and of the fact that his own education was self-directed, gives added value to the pages on "Education and Work". In these pages he betrays a little impatience with the many for whom, with the passing of childhood, there comes the paralysis of curiosity and atrophy of the power to observe. They are so unlike himself. He remained curious and observant to the end. If a man more than seventy years of age cannot keep occupied, it is because there was lack of interest in a sufficient number of things when he was younger. He announced his intention of having a sign put up all over his plant reading, "There is no expedient to which a man will not resort to avoid the real labour of thinking".

With Edison, thinking led to an intense desire to work and to experiment. "No human being can live long without work", he writes in one of his sundry observations—the pleasure of idleness is one of the great superstitions of the human race.

Edison's observations on the possibilities of atomic energy, his somewhat casual remarks on the influences that make for peace or war and his comments on disarranged economic systems—all these make reading which is the more interesting because of all that has happened since the last of these lines was written. Reading the pages of this book, we feel that here was no recluse, no experimenter shut away in his laboratory from the rest of the world; here was one who was of the people, working for the people. "I consider," he writes, "that the first mission of the motion picture is to make people happy, the second—to educate, elevate and inspire."

This is a book to have on one's shelves and to dip into for five minutes when one feels depressed.

W. G. R.

# UNIVERSITY DEVELOPMENT IN GREAT BRITAIN

THE University Grants Committee has always regarded itself fundamentally as a channel of communication between the State and the universities of Great Britain, and before the War this function was expressed mainly in the interpretation to the Government of the policies and financial needs of the universities. The increasing dependence of the universities on Government support makes it equally important that these policies and needs should also be interpreted to the general public. That function is admirably discharged by the present report*, which summarizes conveniently, with diagrams and comparative statistics, the changes that have occurred in what has probably been the most eventful twelve years in the history of most, if not all, of the universities of Great Britain. Although the new terms of reference of the Committee will make it increasingly concerned with the task of assisting the universities to plan their developments on lines that will meet as closely as possible the needs of the community, the new function will never diminish the importance of the old one of interpretation, both to the Government and to the community.

Before discussing post-war developments and problems, which occupy almost three-quarters of the report, the Committee deals briefly, in successive chapters, with the period 1935–39, the war years and with the revival of the universities after the War; and the narrative is illustrated by numerous appendixes which record changes in the membership of the Committee itself since 1936, the membership of the sub-committees constituted to deal with its new functions, university income and expenditure under main heads, capital benefactions and major additions to university buildings for 1946–47 in comparison with 1935–36, total numbers of students for 1938–39 and in the autumn term 1947 and of assisted students. Details are given of the arrangements for the deferment and call-up of university students, the call-up of university staffs for national service and of the war-time location of the University of London, its colleges and schools. Indeed, the report is a well-nigh indispensable reference work on university development in Britain, and the change in format will render its use for such purposes more generally convenient. Publication of the annual statistical volume of Returns from Universities and University Colleges in receipt of Treasury Grant, suspended since 1938–39, is to be resumed with the volume covering the academic year 1947–48.

The three changes recorded in the grant list since the last report in 1936 are the grant by the Privy Council to University College, Nottingham, of a charter of incorporation as a full university, the formal admission of the University Colleges of Leicester and Hull to the grant list, and approval of financial support for the establishment of a new University College at Stoke-on-Trent, subject to the grant of the necessary royal charter and arrangements for effective sponsorship by one or more universities. During the whole period covered by the report, the total income of the universities of Britain was more than doubled, rising from £6,060,995 in 1935–36 to £13,043,541 in 1946–47, the principal increases being £4,803,000 from Parliamentary grants, £1,052,000 from students' fees, £342,000 from endowments and £194,000 from local authorities. The increase in the Exchequer grant came mainly in 1945, and the proportion of the total income of the universities which is derived from the State has now risen from 34·3 per cent in 1935–36 to 52·7 per cent, and by 1951–52 may well be more than 60 per cent.

Before discussing the implications of this development, the report refers to non-recurrent grants and to the acceptance in principle, by the Chancellor of the Exchequer, of the Committee's estimate that the capital needs of the universities for the quinquennium 1947–52 would amount to some £40,000,000 for new building and £10,000,000 for site and equipment, of which by far the greater part would have to be found, if at all, by the Exchequer. At the same time, the Chancellor indicated that in view of unavoidable restrictions on new construction, it was unlikely that more than £20,000,000 of building work would be possible in the quinquennium, and subsequent deterioration in the building situation makes it very doubtful whether even this estimate can be fulfilled. Nevertheless, capital benefactions received by the universities during the twelve years under review amounted to £14,366,872, of which £5,996,636 was for the erection of new buildings or the acquisition of land and properties, £6,798,794 for endowments and £1,571,442 for the establishment of fellowships, scholarships and prizes. During the years 1935–36 to 1944–45, approximately £6,700,000 was expended by the universities on the erection of new buildings and purchase of properties, chiefly before the War. Total expenditure in 1946–47 was £12,951,071 as against £6,141,401 in 1935–36.

The quinquennial system of assessing grants was re-introduced in 1947, and by 1951–52 the contribution from the Exchequer to recurrent university purposes will have risen to about £13,000,000. The new and enlarged conception of the responsibility of the State in the field of university education has caused the Committee to reconsider seriously the principles which should govern the distribution among the universities of the money at its disposal. It considers its function to be not direction, but stimulation, co-ordination and advice; consequently, although the Committee has earmarked certain grants for special fields of study for reasons of national policy, it regards this device as unsuitable for permanent adoption because it impairs to some extent the universities' freedom of action. This principle of directing public money most freely into the channels in which it seems likely to produce the most fruitful results—a policy of helping those who help themselves—unlike the obvious criteria of need, is one that may favour the senior universities and those modern universities which have received the largest measure of support. Endowment income in 1946–47 still remained at 9·3 per cent over Great Britain as a whole but varied widely among the universities, averaging, for example, only 3·1 per cent in the University of Wales as against 10 per cent for those of Scotland.

* University Development from 1935 to 1947. Being the Report of the University Grants Committee. Pp. 106. (London: H.M. Stationery Office, 1948.) 2s. net.

The report shows that the University Grants Committee is well aware of the difficulties which may arise in reconciling the claims of achievement with those of need, and it cites professional salaries as a pertinent example. The report details the reasons which led the Committee to recognize variations in such salaries as a permanent feature of university finance in Britain. The Committee finally decided to compromise on a plan which reduced the existing inequalities and recognized for all institutions a standard rate of professional salary, and assessed for each institution a sum which in the Committee's view might properly be expended in raising the salaries of some professors above the standard rate. While the factors to be taken into account in determining this assessment are indicated, the Committee did not seek to determine or to suggest the salary to be paid to a particular professor, and the arrangement is believed to have been accepted by the universities generally as a reasonable settlement.

That example itself indicates something of the character of the new and intricate relationship between the State and the universities which it is a main purpose of the report to illustrate. Moreover, the Committee regards as one of its most important functions that of devising appropriate means of reconciling the central planning of university developments with the maintenance of the essential academic freedoms. The need for some form of central planning is well recognized by the universities themselves, and the Committee believes that such planning is not irreconcilable with academic autonomy. It believes that the duty of ensuring that the large grants from the Exchequer are expended in the way best calculated to promote the public welfare can be discharged by the Committee in a relationship between the State and the universities which may properly be conceived as a form of partnership. Indeed, it suggests that the most serious threats to academic autonomy in Great Britain come rather from other external sources, such as benefactions accompanied by restrictive conditions, or from factors which in devious ways diminish the vigour of academic life.

The full extent of university dependence to-day on Government support is revealed not only in the financial sections of the report just outlined. It is further shown in the section of the report which deals with the number of students. After the fall in numbers during the War from 50,000 to 35,500 in 1943–44, largely in the faculty of arts, where the number of men students fell from nearly 15,000 to about 3,500, by October 1947 numbers had risen again to 77,000, and estimates received from the universities by the Committee indicate that by the end of ten years they expect to be able to deal with 88,000 students, or only 2,000 short of the total figure required to meet the recommendations of the Barlow Committee on Scientific Man-power. Expansion has been greater than expected in the Universities of Oxford and Cambridge and in many of the London colleges, but has been mainly in the provincial universities. Pre-war numbers in science and technology have been approximately doubled, but numbers in the faculties of arts have only risen by 50 per cent, and the Committee considers that it is unlikely that additional students in arts will be forthcoming to bring the number up to 10,000. For some years to come the proportion of students engaged in scientific and technological studies is likely to be higher than it was before the War.

The Committee suggests that this ratio should be kept in mind; but it is more concerned with the question of quality, both of students and of academic standards. Little direct evidence is yet available of the capacity of the schools to provide a largely increased supply of freshmen of the quality necessary for a university career, and the report emphasizes that more than a third of the students at present in the universities are receiving grants under the Further Education and Training Scheme. While this scheme is temporary, the percentage of full-time students receiving assistance in some form or other from public funds had risen in 1946–47 to 67·9 as compared with 41·1 in 1935–36, and the University Grants Committee believes that if the present number of students in the universities is to be maintained, still more if it is to be exceeded, subsidies on an unprecedented scale will be needed. The report briefly reviews the new problem of selection which these conditions present, starting with the assumption that the universities must not be deprived of an effective choice of their own entrants; its observations should be carefully noted in considering the recommendations of the Working Party on University Awards which have since been published.

Next, however, the report considers the bearing of the quality of the life and education which the universities are able to provide and the maintenance of university standards. The effect of the war years on those standards is reviewed in an early chapter; while there were certain imponderable gains, the balance was heavily on the debit side. Now the rapid increase in the number of students has imposed heavy strains on staff and students alike, which in some respects have involved serious deterioration in the standards of university life. The Committee is convinced that unless additional accommodation can be speedily provided, the present student numbers cannot be maintained without grave risk of impairing, not only academic standards which can be measured directly by examination results, but also those imponderable elements which form so valuable a part of university life. To quote the report:

"Unless there are considerable additions to accommodation, some universities will not be able to increase their staffs further. Moreover, a number of universities find themselves unable to make the fullest use of their existing staff owing to lack of accommodation for discussion groups and individual tuition. In some universities there is no room in Union or Library for a large proportion of the students; the present shortage of books adds further to the pressure on the libraries. At many universities there are, every day, long queues waiting for places in refectories which, even though enlarged considerably since the war, are quite inadequate for present numbers. A leisured university life with adequate opportunities for regular contacts between staff and students is rarely possible."

Elsewhere in the report the Committee states that there are no universities in Britain in which the provision of large new teaching blocks is not a pressing necessity, and that both teaching and research are seriously hampered by lack of space. Nevertheless, while stressing the vital importance of sufficient private rooms for staff and of taking a broad and imaginative view of the future in planning new libraries or extensions of the libraries, the Committee endorses the view that the further provision of halls of residence should be a primary object of university policy during the next decade, in spite

of the difficulties of implementing such a policy at present. In many universities the greatest contribution which can be made to student life at this time is the increased provision of central amenities.

Apart from the physical aspects of university expansion and their bearing on the maintenance of university standards, the University Grants Committee is seriously concerned with the staff conditions. Reference has already been made to over-work and lack of leisure; and the point is reiterated in respect of the research worker, whose most elementary need, coming before even that of suitable equipment for research, is that of sufficient leisure from the pressure of other duties. In regard to research equipment, the Committee incidentally again refers to the importance of library expansion, and looks for some improvement in the facilities for the publication of learned works. One of the principal and most difficult problems confronting the universities is that of recruiting academic staff in sufficient numbers for the discharge of their wider responsibilities. Apart from the increase in the student population, in the spring of 1944 only 68 per cent of the holders of full-time teaching posts on normal establishments remained, 78 per cent of senior administrative and 57 per cent of library staffs. Altogether, some 1,380 members were absent in the Forces or on some form of national service. Furthermore, there is now a call for an increase in the ratio of staff to students, partly to permit students to receive much more individual tuition and partly to free more time for research. With the demand for specialized teachers and research workers arising out of the introduction of new subjects, the Committee estimates that the numbers of full-time staff should be increased during the decennium from the pre-war figure of 4,000 to not less than 10,000. By 1946–47 the number had risen to more than 5,500; but the maximum to be expected by the end of the quinquennium is estimated at 8,000. Questions of salary are discussed in some detail, and the report urges that all universities should review their administrative arrangements with the object of relieving their professors and heads of departments of any duties that do not necessarily demand their personal attention, and also that means should be found of enabling a larger proportion of lecturers to participate more directly in the administrative business of the university.

The report deals very briefly with such general academic problems as the place of research, curricula and teaching methods; but a section discusses a number of specific problems, mostly arising out of Government reports such as those of the Goodenough Committee, the Loveday Committee on Higher Agricultural Education, the Scarborough Committee and the Clapham Committee. The University Grants Committee has itself appointed a separate sub-committee to deal with technology, which will consider the recommendations of the Percy Report; but the work of this Committee falls outside the period of the present report. Finally, the extra-mural work of the universities is reviewed. The majority of the Committee believes that the universities are making and should continue increasingly to make a unique and indispensable contribution to adult education, but that their special function is to foster and intensify study by all means in their power, and to maintain a high standard of qualitative achievement among those engaged in it. The dissipation of resources should be avoided by wise discrimination.

# PROBLEMS OF ORGANIC GROWTH

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ORGANIC growth is, without doubt, one of the basic biological phenomena. Physiology presents a wide realm of experiences concerning factors influencing growth; however, the phenomenon of growth itself remains, as yet, unexplained. Many growth formulæ have been proposed, but none has been generally accepted. Recent investigations, however, seem to provide a consistent theory leading to an explanation of growth in its general ecurse as well as in its specific peculiarities, to quantitative laws allowing calculation and prediction, and towards a unification of the great physiological realms of metabolism, growth and form development[1].

Animal growth may be considered a result of the counteraction of synthesis and destruction: anabolism and catabolism of the building materials of the body. There is growth so long as building up prevails over breaking down; the organism becomes stationary if and when both processes are equal. This may be expressed in a general formula which contains no hypothetical elements:

$$\frac{dy}{dt} = \eta y^n - \varkappa y^m.$$

In words: the change in body weight $y$ is given by the difference between synthesis and destruction of building materials; according to general physiological experience, these processes will be proportional to some powers, $n$, $m$, respectively, of the body weight: $\eta$ and $\varkappa$ are constants of anabolism and catabolism.

To make use of this consideration, the processes involved must be defined. Catabolism is represented by the continuous loss of building material, and corresponds, in the higher animal, to what is called *Abnützungsquote*, or quota of wearing out (Rubner). Physiological experience shows that it is, to a good approximation, proportional to body-weight, so that the exponent $m$ can be made equal to 1.

With respect to anabolism, a number of different cases can be distinguished. A survey of the types known hitherto is given in the accompanying table.

In micro-organisms[2], the character of the growth curves depends simply on the geometrical shape. In the case of spherical forms (yeast, micrococci) where the ratio of surface to volume decreases with increasing size, we find a decrease of growth-rates; on the other hand, rod-shaped forms (bacteria) which grow almost exclusively in length and where, therefore, the surface–volume ratio remains almost constant, show simple exponential growth. The fact that the surface where the intake of material takes place is a regulating factor of growth also in lower animals was demonstrated quantitatively in planarians by *measurements of the intestinal tract*[3]. The most interesting case is, however, growth in multicellular animals.

One of the classical problems of physiology is the dependence of basal metabolism upon body-size.

METABOLIC TYPES AND GROWTH TYPES

*A. Anabolic processes depend on resorption (resorbing surfaces).* (*a*) Micro-organisms: (1) Proportional growth: linear and volume growth curve as $B\,I$; spherical bacteria, yeast. (2) Growth almost exclusively in length: linear and volume growth curves exponential; rod-like bacteria. (*b*) Probably turbellarians.

*B. Anabolic processes depend on respiration.*

| Metabolic type | Growth type | Examples |
|---|---|---|
| I. Respiration *surface proportional* | (*a*) Linear growth curve: attaining *without inflexion* a steady state. (*b*) Weight growth curve: *sigmoid*, attaining, with inflexion at *c.* 1/3 of final weight, a steady state | Lamellibranchs, fish, mammals |
| II. Respiration *weight proportional* | Linear and weight growth curves *exponential*, no steady state attained, but growth intercepted by metamorphosis or seasonal cycles | Insect larvæ, Orthoptera, Helicidæ |
| III. Respiration *intermediate between surface and weight proportionality* | (*a*) Linear growth curve: attaining *with inflexion* a steady state. (*b*) Weight growth curve: *sigmoid*, similar to I (*b*) | Planorbidæ |

The fundamental formulation is the well-known *surface rule* of Rubner stating that in warm-blooded vertebrates basal metabolism, as measured by oxygen consumption, carbon dioxide or heat production, is a function not of weight but of surface. It is well known that this rule has been explained by Rubner through the exigencies of homeothermy. Later research[4], and especially a series of investigations carried through in our laboratory[5], has, however, demonstrated two important facts. First, the surface rule holds good also for many poicilothermous animals, vertebrates and invertebrates, so that the rule is of wide application; but the explanation given by Rubner is too restricted. On the other hand, there are also other modes of dependence of metabolism on body-size. Therefore, we arrived at the statement of *metabolic types* in respect of the relation between respiration and body-size.

Just as there are several metabolic types, there are also different *growth types*, distinguishing themselves by different growth-curves. We succeeded in establishing a connexion between metabolic types and growth types, providing an explanation and quantitative laws, and leading to the foundation of a comparative physiology of growth.

Investigation has shown that respiration is to be considered a limiting factor of anabolism of building materials. Inserting into the basic equation that value of $n$ which is found experimentally for size-dependence of respiration, the growth laws of the organism in question follow automatically. It is possible, therefore, to *predict* the growth type of an animal from its metabolic type. This 'forecast' was confirmed in all cases hitherto investigated, sometimes leading to completely unexpected results. This system of growth laws has been applied to a considerable number of growth curves, including micro-organisms, tissue cultures, crustaceans, lamellibranchs, snails, hemimetabolic and holometabolic insects, fish, mammals, man, regenerative growth, etc., giving good numerical agreement in all well-investigated cases.

Since the constant $\varkappa$ of the growth equation represents the wearing-out quota, the values of $\varkappa$ as calculated from the growth curves should be identical with the values of protein catabolism, as measured by physiological experiment. In fact, the calculated values have been confirmed in a number of cases, including lamellibranchs, crustaceans, fish, man. This is, however, not true for small mammals: here the calculated values are considerably higher than those determined by the classical physiological methods, namely, determination of nitrogen excretion or protein loss in the starving animal. It was inferred, therefore, that the usual methods give values which are too low and that, in fact, protein metabolism goes on much faster than formerly assumed[6]. But this is just the conclusion which is reached by the modern method of isotope tracers[7]. It appears, therefore, that a combination of these two methods, namely, determination of protein metabolism by isotope tracers, and its calculation from the growth curves, should lead to important insights into this field of metabolism.

Very interesting are the connexions between *sex*, *metabolism*, and *growth*. Take, for example, a species showing remarkable sexual dimorphism in respect to growth and size, like the cyprinodont fish *Lebistes reticulatus*. Calculation of the growth curves shows that the ratio of the anabolic constants $\eta$ in females and males is about $1 : 1\frac{1}{2}$. Theory demands that the same ratio should hold for respiration—and this is found to be the case.

Further application of the theory has been made in respect of environmental growth factors, as, for example, the *dependence of growth on temperature*, which partly coincides with Bergmann's rule in ecology. This leads to the conclusion that, while the growth curve is steeper at higher temperatures, a larger final size is reached at lower temperatures. This result corresponds to the observed data. The methods yielded by the theory can be applied also to the analysis of *geographical variation*, and should be useful for applied biology (fisheries, investigation of nutritional factors, etc.)[8].

So far, the quantitative analysis of growth and the establishment of growth laws consisted only in attempts to fit a number of growth curves to some formula. A rather scattered set of points as is given in observed growth data may very well be approximated, however, by quite different mathematical functions which, therefore, tell nothing about the underlying mechanism. Satisfactory approximation is a necessary, but by no means sufficient, condition, so that we may attach to a mathematical function a rational, as opposed to a merely descriptive, significance. The theory outlined above is of a different character; consequences can and have been deduced from it which can be tested by independent experiment; in some cases predictions have been later verified by experiment in a most surprising way.

The growth theory outlined here is part of a wider theoretical consideration, namely, the conception of the organism as an *'open system'*, exchanging materials with its environment and approaching, in general, a steady state[9]. We cannot consider this point of view here, and may mention only that therefrom follows the *equifinality* of growth, that is, the fact that the same final state may be reached from different initial sizes (for example, individuals with different birth-weight in litters of different number) or after temporary suppression of growth (for example, by temporary undernutrition or vitamin deficiency). Also the *rule of constant cell size* is a consequence of the equifinality of growth. The concept of open systems has also been applied to the *biological elementary units*, viruses, genes, and chromosomes[10], and a physical model has been indicated[11]. According

to these considerations, self-duplication in viruses and genes results from the fact that they are 'metabolizing aperiodical crystals'. At least in respect of chromosomes, this conception appears to be well founded since tracer investigation has shown that the nucleoproteins of the cell are continuously worn out and replaced[12].

Further investigations have been made in respect of *relative growth*. Allometry is a valuable tool in the investigation of metabolism[13]. In fact, the older disputes on the bearing of the surface rule have been caused largely by the fact that only arithmetical methods, and not allometric plots, have been applied. The latter has been done in more recent investigations, leading to our distinction of metabolic types, as mentioned above.

Another interesting phenomenon is the dependence of *physiological rhythms*, such as pulse and respiration frequency, on body-size[14]. According to the general principle that, roughly speaking, metabolism is relatively higher in small, as compared with big animals, pulse- and respiratory-rates decrease with increasing size. Quantitative analysis starting from the surface relation of basal metabolism, and taking into account the allometries of heart-size and beat-volume, leads to a rather remarkable result. The theoretical allometry of pulse-rate deduced from the factors mentioned corresponds astonishingly well with empirical data in a vast range of seven orders of magnitude, from the dwarf bat weighing 4 gm., with a pulse-rate of about 1,000 per min., to the elephant weighing 2,000 kgm., with a pulse-rate of 25 per min. Since in this deduction very crude approximations have been made, and anatomical, physiological and ecological peculiarities of the animals in question have been neglected, this result shows that simple size-dependence is the governing factor of pulse-rate. Similar conclusions apply to respiratory frequencies.

According to Huxley[15], we find in organisms and organs growth gradients which can be defined by the allometry constants of the different regions. On the other hand, there are, according to Child[16], 'physiological' gradients manifesting themselves in differences of susceptibility, metabolism, and morphogenetic activity. The connexion between growth gradients (Huxley) and physiological gradients (Child) is an important but hitherto uninvestigated problem. We have studied it in the classical object, namely, planarians, in order (1) to establish the relation between the different kinds of gradients; (2) to test Child's gradients in a quantitative way; and (3) to establish quantitative laws of toxic action[17].

The results have been rather fatal for Child's theory. In planarians, no connexion between growth and 'physiological' gradients can be found. Further, a quantitative analysis shows that even a primitive organism like a planarian is not characterized by a single axial gradient; but shows rather a bundle of axial gradations in respect of different physiological phenomena. These investigations have been continued in an extensive study of the toxic action of a group of substances of pharmacological interest, namely, the quinones. With respect to the gradient problem, different toxic actions have been distinguished and, as a new result, complete 'gradient inversion' was found, corresponding to definite molar concentrations.

Simultaneously, the *quantitative laws of toxic action* have been studied. The effect of concentration follows the equation $tc^a = b$ ($t$ = time, $c$ = concentration, $a$ and $b$ = constants), which is known also in other pharmacological reactions[18], and can be considered, from the physico-chemical point of view, as an adsorption isotherm, from the biological, as an application of allometry to pharmacological action.

Further, a *unification of the theory of growth in time and of relative growth* has been attempted[19]. These derivations lead to expressions which describe time-growth of organs without introducing new constants besides those of total growth and of allometry. Some consequences of this theory are that growth curves of linear dimensions should have no inflexion in organs of negative allometry and isometry, but should be sigmoid in the case of positive allometry; that in undernutrition organs of positive allometry should increase at the cost of others; that in starving animals organs showing positive allometry should decrease faster than those showing negative allometry or isometry, etc.

The conception of organic growth outlined here leads to important conclusions in respect of basic problems of evolution, such as orthogenesis, phylogenetical laws, bearing of selectionistic interpretations, role of hormonal changes, peculiarities of the descent of man, etc.[20]. Without entering into details, the relation to recent phylogenetic theory may be mentioned[21]. Thus, a vast range of problems, extending from physico-chemistry to physiology and morphological questions, is approached in this conception.

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# AUREOMYCIN, A NEW ANTIBIOTIC

A VERY important series of sixteen papers on aureomycin has been published in the *Annals of the New York Academy of Sciences*, vol. 51, Art. 2, pp. 175–342 (November 30, 1948). These papers were the result of a conference on aureomycin held by the Division of Mycology of the Section of Biology, the New York Academy of Sciences, on July 21, 1948. They represent the work of forty-three investigators, sixteen of whom are on the scientific staff of the Lederle Laboratories Division, American Cyanamid Company, Pearl River, N.Y. The remainder are well known and independent biological and medical research workers in official laboratories, university medical schools and hospitals, all of whom were supplied with aureomycin by the Lederle Laboratories.

In the introductory paper, B. M. Duggar, of the Lederle Laboratories, traces the history of the discovery of the new antibiotic, and pays tribute to his late colleague, Dr. Y. SubbaRow, who directed the work until his death. Aureomycin, which has been obtained as a highly purified, crystalline, faintly golden-yellow substance, is a metabolic product of *Streptomyces aureofaciens*, a hitherto undescribed species of the Actinomycetes. Hence its name, and not, as a London evening newspaper has recently stated, "because it can be given by the mouth". It has clearly been made in considerable quantities—fermentation in tanks is mentioned—but few details are given of the methods used for the production and isolation of aureomycin, and chemists will look in vain for any information as to its chemical nature, except what can be gleaned from the fact that a hydrochloride and a borate are referred to. To avoid confusion, mention should be made of the fact that the trade mark 'Duomycin' has been given to aureomycin.

*In vitro* bacteriological studies of aureomycin, carried out in the Division of Penicillin Control and Immunology, Food and Drug Administration, Washington, in Johns Hopkins University School of Medicine and in Boston City Hospital and Harvard University Medical School, have established that aureomycin is effective against both Gram-negative and Gram-positive bacteria. Higher concentrations of the substance are required to produce bacteriostasis than are necessary with penicillin, being close to those required of streptomycin. Bacteria do not readily become resistant to it *in vitro*. It seems to be rather unstable in aqueous solution even at room temperature, though the dry solid material appears to be quite stable. An exhaustive study of the pharmacology of aureomycin, carried out in the Lederle Laboratories and at Johns Hopkins, established that it has a low toxicity and almost no side reactions, particularly in solutions of *p*H 8·5.

P. A. Little, in the Lederle Laboratories, found aureomycin effective in experimental infections in mice of *Eberthella typhosa*, *Erysipelothrix rhusiopathiæ*, the causative agent of swine erysipelas, and also in chickens infected with the causative agents of fowl cholera and fowl typhoid. On the other hand, workers at Johns Hopkins failed to protect mice with aureomycin administered orally in experimental infections with *Pneumococcus* type I or *K. pneumoniæ* A., although it did protect against *Streptococcus hemolyticus* beta, and Dr. Henry Welch and his colleagues at the Food and Drug Administration, Washington, conclude that "no outstanding usefulness for this antibiotic has been demonstrated by our animal investigations against the bacteria studied. The greatest promise for the drug lies in the treatment of certain viral and rickettsial diseases."

In spite of the not altogether favourable laboratory findings, clinical trials of aureomycin in human patients have given very promising results. About a hundred patients with a variety of bacterial infections have been treated with aureomycin by mouth at the Boston City Hospital. The results obtained in cases of gonorrhœa, while indicating that this treatment was effective in many cases, were inferior to those obtained with adequate amounts of penicillin. Four patients with pneumococcal pneumonia were successfully treated with aureomycin by mouth. In a number of urinary tract infections the results were favourable, and may be comparable with or possibly superior to those obtained from the use of streptomycin in similar cases. In contrast to streptomycin, there was no evidence of the development of bacterial resistance to aureomycin *in vivo*. Infections with *Proteus vulgaris* and *Pseudomonas aeruginosa* were not benefited by aureomycin. The results in the cases of typhoid fever and of severe *Salmonella* infections were equivocal. Workers in the George Washington University Medical Departments also failed to obtain any clinical or bacteriological response in four patients with typhoid fever. The results obtained by workers at Johns Hopkins in four cases of primary atypical pneumonia were very similar to those of the Boston workers. Eight cases of chronic urinary tract infection, which had not responded to penicillin, streptomycin or sulphonamide therapy, cleared promptly with aureomycin. A. E. Braley and M. Sanders, of the Department of Ophthalmology, College of Physicians and Surgeons, Columbia University, New York, report favourably on results with aureomycin borate used locally and aureomycin hydrochloride used intramuscularly in two hundred patients with a wide range of ocular infections, and found the antibiotic to be effective against some of the Gram-positive cocci and several Gram-negative bacilli. It was also found to be an effective therapeutic agent in the virus infections, inclusion conjunctivitis and herpes simplex of the cornea.

Indeed, even more striking than the antibacterial activities of aureomycin are its effects on viruses and rickettsiæ. S. C. Wong and H. R. Cox, of the Lederle Laboratories, have shown that although it has no apparent *in vitro* activity, it has marked therapeutic activity against the viruses of the psittacosis-lymphogranuloma group and rickettsiæ of the spotted fever, typhus fever, scrub typhus fever and *Q* fever groups in embryonated hens' eggs, mice and guinea pigs. On the other hand, it failed to show any therapeutic activity against a number of other viral infections, notably the *B* strain of influenza, canine distemper and the *MEF*-1 strain of poliomyelitis. Investigators in the rickettsial research laboratory of the University of Texas report favourable results in the treatment of guinea pigs infected with spotted fever and epidemic typhus. Clinical trials of aureomycin in human patients suffering from four different types of viral or rickettsial infections have given very promising results. A group of workers at Johns Hopkins and other investigators in the George Washington University Medical Departments obtained quite dramatic cures in a total of twenty-one cases of Rocky Mountain spotted fever treated with oral aureomycin. Workers in the Harlem Hospital

and Columbia University, New York, treated a total of thirty-five cases of lymphogranuloma venereum, usually by intramuscular injection, and conclude from the excellent results they obtained that aureomycin is the treatment of choice in this virus infection. They also found that the ulcerative lesions in three patients with proved granuloma inguinale were healed by the use of this antibiotic. Finally, fifteen *Q* fever patients were treated with oral aureomycin by a group of Californian workers. In fourteen patients improvement occurred relatively promptly after commencement of the therapy, and the investigators conclude that oral aureomycin therapy offers considerable promise in the treatment of this fever.

Although it may be unwise to do so, one is tempted to try to assess the probable future importance of aureomycin in relation to three other antibiotics of proved clinical importance, namely, penicillin, streptomycin and chloromycetin from *Streptomyces venezuelæ*. In the treatment of most Gram-positive bacterial infections, the supreme position of penicillin remains unchallenged. Streptomycin appears to hold a similar though less exalted position in the treatment of many tubercular infections; but it seems probable that aureomycin may displace streptomycin in the treatment of many Gram-negative infections, particularly of the urinary tract, because of the unquestioned advantage it possesses that bacteria do not become resistant to it *in vivo* as they often do to streptomycin. In the treatment of viral and rickettsial diseases, both chloromycetin and aureomycin offer considerable grounds for hope in infections which have so far proved very resistant to chemotherapeutic agents. Whether these two antibiotics will prove to be competitive with, or supplementary to, each other only the future can tell. In the meantime, British investigators will wish to congratulate their American colleagues in the Lederle Laboratories on a very noteworthy achievement. HAROLD RAISTRICK

## POST-GLACIAL CLIMATIC CHANGE

A WELL-ATTENDED joint meeting of the Royal Meteorological and Royal Astronomical Societies on December 15 discussed recent work on changes of climate since the Ice Age. The discussion was opened by Mr. F. Hoyle, who said that any persistent change in the temperature of the earth's surface must depend ultimately on radiation from the sun. Without some external cause, solar radiation would not change appreciably in many millions of years, neither would the mean distance of the earth from the sun. But the sun travels through a gaseous medium which is aggregated locally into clouds, and in passing through such a cloud it would sweep up a number of particles. The kinetic energy of these, falling into the sun, is converted into heat, which might increase total solar radiation by as much as ten per cent. All this excess energy appears in the ultra-violet part of the spectrum, but as the latter normally forms only one ten-thousandth part of the solar radiation, passage through a cloud would magnify the ultra-violet many times. This radiation is absorbed in the higher levels of the atmosphere and might alter its whole behaviour, causing great changes of climate.

The strongest evidence for post-glacial changes of climate is biological, and Prof. H. Godwin described the analysis of frequencies of pollen grains. These show the successive incoming of birch, pine and hazel, elm, oak, lime and alder, indicating a progressive amelioration of climate. The sudden expansion of alder and lime about 6000 B.C. marked the beginning of the Post-glacial Climatic Optimum, a warm period which continued until about 3000 B.C., after which the climate again deteriorated. There was a rather sudden worsening about 500 B.C., with flooding horizons and other evidence of increased rainfall. But the interpretation of biological evidence is sometimes difficult. It depends mostly on the present range of the species; but the regional range may be confused with what Prof. Godwin termed the 'microclimatic range', which allowed of local occurrences in exceptionally favoured spots outside the main range.

Prof. Godwin gave an interesting example of a new technique in the analysis of floras, in the climatic control of holly, ivy and mistletoe. A number of meteorological stations are selected and the performance of nearby plants noted—whether they bear ripe fruit regularly, occasionally or never, or whether the plant is not found in the district. These are plotted on diagrams against the mean temperatures of the warmest and coldest months. In this way the 'thermosphere' of each species is defined. Holly and ivy are controlled by the winter temperature, mistletoe by the summer temperature. Prof. Godwin illustrated a region in which the two former are at present flourishing, while mistletoe does not ripen its fruits (mild winters, cool summers). In the Sub-boreal, ivy and mistletoe flourished but not holly (cold winters, hot summers). During the Climatic Optimum, however, all three plants ripened their fruits, indicating mild winters and warm summers.

Climatic changes in the historic period were described by Prof. Gordon Manley, who compared long instrumental records of temperature with advances and retreats of glaciers. The greatest post-glacial expansion of glaciers began in Scandinavia so late as 1750, in the Alps about 1550 and in Iceland probably as early as 1350. Glaciers are now everywhere in rapid retreat, and in Norway archæological remains have been uncovered dating from 1300. Long records of temperature have been carried well back into the eighteenth century at Stockholm, in Holland, and by Prof. Gordon Manley himself in Lancashire. There are difficulties of exposure and of local change of climate due to urbanization, but the general agreement is sufficient to show that the major oscillations are real. The principal feature has been a rise of winter temperature while the summer temperature has maintained a generally constant level; the annual range has everywhere decreased. The temperature records fit in very well with the records of glaciers; in particular, the chilly springs about 1740, which were general and in places catastrophic, decreased the ablation period for glaciers and were followed by glacial advances.

Prof. Gordon Manley then discussed possible causes. Dr. Ångstrom considered that periods of maritime climate were due to increases of the atmospheric circulation, but this only carries the problem back one stage. Moreover, the great fall of temperature about 500 B.C. requires some other factor, and this may be found in the spread of Arctic ice and melt-water. Low spring temperatures result from the frequent inflow of polar maritime air; mild winters with little frost are associated with maritime tropical air, and resemble the conditions in the

Climatic Optimum. It is probable that the changes from year to year due to changes in the circulation are of the same order of magnitude as the average changes between the different post-glacial periods, and the problem now becomes that of finding out why such conditions persisted through decades or centuries instead of only for a year or two at a time.

Dr. C. E. P. Brooks said that the extreme climate, with cold winters and hot summers, which followed the retreat of the ice, could reasonably be put down to the combination of a greater inclination of the earth's axis and the fact that the earth was only just passing out of the condition in which the northern hemisphere was in aphelion in winter. The Climatic Optimum, which was not only mild but also seems to have been on the whole a period of greater rainfall than the present, required some other explanation. The highest temperatures preceded the maximum submergence of the Litorina Sea in Scandinavia; moreover, such a local cause could not explain a change over the whole hemisphere. He thought that the most likely cause was an increase of solar radiation, and he asked whether this could have been brought about by a cosmic cloud. Later, Prof. E. A. Milne and Mr. Hoyle replied that there could not be clouds small enough to cause changes of only a few hundred years, and, though there may be changes of density within a cloud, astronomical theory cannot be tied up with recent climatic changes.

The period which comes at the end of the Climatic Optimum had a peculiar, very extreme climate. Botanists thought that there were alternating contrasted periods of heavy rainfall and drought; at the end, from about 800 or 700 B.C. until 500 B.C., was a 'dry heat wave', after which the climate became very wet and stormy. Such oscillations must be due to changes in the frequency and tracks of depressions, and these might result either from changes of solar activity as indicated by the frequency of sunspots and auroras, or from changes in the outflow of Arctic ice into the Atlantic. The curve of solar activity cannot be traced with any reliability before A.D. 1000, and though there is some resemblance to the variations of rainfall, this is not very close. Dr. Brooks then referred to a theory put forward by O. Pettersson in 1914 that changes of climate since about 3500 B.C. were due to variations in the tides, and particularly in the submarine tides at the boundary of the Atlantic and Arctic. Tidal maxima occurred about 3500 B.C., 1900 B.C., 250 B.C. and A.D. 1433, and about these dates the Arctic ice-cap would tend to be broken up and much ice drift out into the Atlantic. These maxima agreed very well with the periods of maximum rainfall in the northern hemisphere, derived from peat bogs, levels of lakes and rivers, migrations and documentary evidence. He thought that after the Climatic Optimum, before the Arctic ice-cap had firmly re-established itself, the changes of climate resulting from changes in the ice would be very large. With regard to minor oscillations of the order of a decade, he asked if they must have a cause. Could they not just happen, as variations happen in any random series of events?

Mr. D. J. Schove described recent documentary evidence from China, which pointed to great droughts in the third and fourth centuries A.D., floods in the eleventh and drought in the twelfth. He remarked that in Europe the first half of the sixteenth century was very similar to the first half of the twentieth, but about 1540 there was a sudden change to good summers and cold winters. Other speakers mentioned the possibility of causes such as the disappearance of seaweed in the Sargasso Sea and the occurrence of great volcanic activity, for example, in the Rift Valley of Africa. Prof. P. A. Sheppard remarked on the tendency to look for the causes of climatic change everywhere but in the atmosphere, which goes through quite considerable swings not inspired directly by the sun. Although these are generally short-lived, they may be slowed down by the influence of a snow-cover, which may cause long-period variations.

The discussion showed that the various lines of attack on the problem of climatic change are beginning to converge. Our knowledge of the succession of events is becoming very detailed, and the meteorology of climatic change is becoming clearer; but there is not yet any general agreement on the causes. Variations of solar radiation are fundamental, however, and the problem is not likely to be finally solved until these have, in one way or another, been elucidated.

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# OBITUARIES

## Prof. J. H. Maclagan Wedderburn, F.R.S.

JOSEPH HENRY MACLAGAN WEDDERBURN, emeritus professor of mathematics, Princeton University, died at his home in Princeton on October 9, 1948, at the age of sixty-six.

Prof. Wedderburn was born at Forfar in 1882 and educated in Edinburgh, where he graduated in 1903. While still an undergraduate, he was elected in 1902 to membership of the Edinburgh Mathematical Society, and soon afterwards, in 1903, to fellowship of the Royal Society of Edinburgh, which later, in 1921, awarded him the Makdougall–Brisbane Prize for his researches into hypercomplex numbers. He obtained the degree of D.Sc. of the University of Edinburgh in 1908. During 1905–9 he was assistant to Prof. George Chrystal, and is remembered as introducing the course in general analysis; but the natural bent of his mind was towards abstract algebra. This interest had been fostered by post-graduate residence in Leipzig, Berlin and Chicago, especially the last, where his mentors, E. H. Moore and L. E. Dickson, were to him a help and permanent inspiration. His first papers on modern algebra were published in 1905 in the *Transactions of the American Mathematical Society*. At the age of twenty-five he had acquired a mastery of the structure of algebras and had made a classical contribution to the theory of semi-simple algebras.

In 1909 Wedderburn left Edinburgh and joined the faculty of mathematics at Princeton University. The First World War interrupted his career for five years. He served in the Seaforth Highlanders, later in command of an observation group in the Royal Engineers, and was mentioned in dispatches. It is characteristic of his unassuming disposition that he had enlisted as a private.

Returning to Princeton, Wedderburn was assistant professor of mathematics during 1921–23, then associate professor until 1928, and finally full professor until he retired in 1945. In 1933 he was elected a fellow of the Royal Society. He never married, and was accustomed to spend his vacations in a remote farm in the Adirondacks.

Wedderburn was not a prolific writer, committing himself to publication only when he had something

of essential significance to impart. This gives an impression of reserve and distinction to his work. The present eminence of American mathematicians in algebra owes not a little to his pioneering, to his excellent teaching and to his editorship-in-chief, for nearly twenty years, of the *Annals of Mathematics*, which in 1911 became the charge of the Department of Mathematics at Princeton, and steadily rose to its present distinguished position among the mathematical periodicals of the world. The volume of the *Annals* published in 1946 was in effect a *Festschrift* dedicated to him. This may be taken as an indication of the respect in which he was held, not only by mathematicians in the United States, but also by mathematicians everywhere. A. C. AITKEN

## Dr. George Scott Robertson

GEORGE SCOTT ROBERTSON, permanent secretary of the Ministry of Agriculture, Northern Ireland, died on December 22.

Although his family had been closely associated with Aberdeen for a long period, he was born in 1893 in Middlesbrough, where his father, William Robertson, was for many years editor of the *North Eastern Daily Gazette*. Robertson graduated B.Sc. (Agr.) at Armstrong College, University of Durham, and spent two years there as lecturer in agricultural chemistry. In 1914 he became head of the Chemistry Department of the East Anglian Institute of Agriculture, and in 1920 lecturer in agricultural chemistry at Queen's University, Belfast. A year after going to Northern Ireland he received, for his work on basic slag and rock phosphates, the first D.Sc. degree ever conferred by the University of Durham in its Faculty of Agriculture.

When the Government of Northern Ireland was formed, Robertson's inspiration and drive resulted in the creation of the Faculty of Agriculture in Queen's University, Belfast, which developed in the closest association with the Ministry of Agriculture, Northern Ireland. By 1924 he was professor of agricultural chemistry and dean of the Faculty, as well as senior research officer of the Ministry of Agriculture. By 1933 he became permanent secretary of this Ministry, and for fifteen years directed the work of his Department in peace and war, and saw it grow from a comparatively small organisation into one which to-day touches almost every phase of the life of agricultural Ulster.

Robertson's reputation extended far beyond Northern Ireland. He served with distinction on the Empire Marketing Board, the Imperial Agricultural Bureau, the Food Investigation Board of the Department of Scientific and Industrial Research and the Agricultural Research Council. For many years he was closely identified with the work of Section M (Agriculture) of the British Association; owing to illness, his presidential address at the Brighton meeting last September was read by a colleague.

In 1947 a striking tribute was paid to him when he was invited to become the first director of the new Agricultural Production Division of the Food and Agriculture Organisation of the United Nations. Robertson was absent from Northern Ireland on this work during the greater part of 1947, and when he returned to Belfast it was evident that his health had been impaired by the heavy work he had undertaken—a task superimposed on many years of active endeavour.

Robertson's great services to agriculture in Northern Ireland and in the furtherance of agricultural science throughout the world generally were recognized by Queen's University last year, when the degree of LL.D. (*honoris causa*) was conferred upon him.

His publications include "Basic Slags and Rock Phosphates" (1922) and many other contributions to scientific journals. His main research work was concerned with phosphatic fertilizers in Essex and later in Northern Ireland—investigations which were of outstanding importance and are quoted to-day as classics in their sphere—and pioneer work in collaboration with Sir John Boyd Orr on the mineral requirements of farm livestock.

Robertson was respected for his outstanding ability and qualifications as a leader by his colleagues. He was held in deep and abiding regard as a friend by very many who will mourn his loss.

J. HOUSTON

## M. Louis Rapkine

LOUIS RAPKINE was born at Chichenich in White Russia on July 14, 1904. His father, who was a tailor, migrated to Paris in 1911, taking his family with him, and after a difficult year, went to Montreal, where he worked in a factory. Rapkine grew up as a Canadian citizen. He gained his school education by scholarships. He was a good athlete, excelling in netball and swimming. He spent three years at McGill University, supporting himself by working in the summer vacations. When he was twenty, he left Canada to pursue scientific research in France.

Rapkine's scientific training was unusual, for he never took a doctorate. He worked in the laboratories of Caullery and Fauré-Fremiet, and in Wurmser's laboratory at the Institute of Physico-Chemical Biology. In France, at first, he had very meagre means of support. He kept himself by hawking in the countryside and selling boots at country fairs. Sometimes he starved, and was reduced to eating glucose from laboratory bottles.

In spite of these conditions, Rapkine did important work before he was twenty-one. With various collaborators, he published in 1925 extensive observations on the hydrogen ion concentration in egg-cells by the micro-injection of dissolved indicators. He investigated the oxidation-reduction potentials of the nucleus and cytoplasm, and showed that the old idea that the nucleus was a special centre of oxidation was without foundation. His situation was relieved by the award of a Rockefeller fellowship in 1926. He found that the respiratory quotient for the echinoderm egg at four hours after fertilization was extremely high, and then slowed down. He concluded, contrary to Warburg and Shearer, that in the initial period oxidation-reduction was concerned with synthesis, and independent of respiratory processes. He published a monograph in 1928 on the energetics of the development of the egg. He pointed out that the developing organism may have at its disposal sources of energy other than complete combustion to carbon dioxide and water, and remarked that peak-protein catabolism coincides precisely with the stage of development at which chick embryos best provide plasma for tissue culture. In the same year, he was appointed assistant at the Institute of Physico-Chemical Biology, and afterwards received appointments from the Centre National de la Recherche Scientifique.

Rapkine found that the fertilization of sea-urchin eggs was connected with changes in sulphydryl groups. Multiplication of cells depended on their presence. He was thus led to the study of enzymes. He found that the oxidation of sulphydryl groups was much more rapid when the enzymes were separated from their co-enzymes. He supposed that this was because the co-enzyme was attached to the enzyme in the region of sulphydryl groups, disturbing the access of oxidizing molecules.

The late Sir Frederick Gowland Hopkins had arrived at similar results in part of the sulphydryl work. When he heard of Rapkine's work, he withdrew, so that the younger man should be assured of priority.

By 1939, after a hard struggle, Rapkine was scientifically established. He was thirty-five years old, and had arrived at about the same stage as Hopkins at a similar age. There were resemblances between them in unorthodoxy of career and quality of mind. He became a French citizen just before the Second World War. At the outbreak he was mobilized and sent to London to the office of the French coal-importing organisation, where he compiled statistics.

When France was invaded in 1940, Rapkine set himself to save French scientific workers from the enemy. He compiled a list of fifty-seven, whom he endeavoured to rescue. Without any authority other than his own character, he secured the support of the highest scientific and political personalities in London and Washington. He organised the escape of about forty leading scientific workers from France to the United States. He obtained posts for them, and even got their hospital bills paid.

In 1943 Rapkine negotiated an agreement with the British authorities for the establishment of a French Scientific Mission. He brought the group of French scientific workers in the United States to London to be its staff. This enabled France to receive during and after the liberation much new scientific knowledge and experience. As a consequence, a permanent secretary for Franco-British scientific exchanges was attached to the French Embassy in London. In recognition of this work, he was appointed a Chevalier of the Legion of Honour. Rapkine's last act as an administrator was to negotiate a donation of 350,000 dollars from the Rockefeller Foundation for the assistance of research in France.

Rapkine had revealed unique powers of leadership. Nevertheless, he hurried back to personal research. The Pasteur Institute created a Department of Cell Chemistry for him, and he threw himself passionately into its development. He aimed at the solution of the mechanism of enzyme action. He believed that a single enzyme might be capable not only of one specification, but of many. He was organising a co-ordinated attack on this problem.

Rapkine's premature death, on December 13, is a disaster not only to his relatives and friends, but also to science, and to France. He had an extraordinary combination of moral strength, personal charm and intelligence, kindness, generosity and selflessness, besides practical and scientific ability. Many of those who knew him well regarded him as the finest man of his generation. His wife, who assisted him in his scientific work, and his daughter survive him.

J. G. CROWTHER

# NEWS and VIEWS

## Recent Medal Awards: Geological Society of London

THE Council of the Geological Society has announced the following awards: Wollaston Medal, to Dr. Robert Broom, in recognition of his researches in the field of vertebrate palæontology, especially in the study of the evolution of the reptiles and of the anthropoid apes and man; Murchison Medal, to Dr. E. M. Anderson, in recognition of his investigations of the igneous, metamorphic and stratigraphical geology of Scotland, and of his many original contributions in the field of geophysics; Lyell Medal, to Dr. W. J. Arkell, for his geological researches, especially on the stratigraphy, structure and palæontology of the Jurassic rocks of Great Britain; Bigsby Medal, to Prof. W. Q. Kennedy, in recognition of his petrological researches and for his outstanding contributions in the field of tectonic geology; Wollaston Fund, to Mr. E. C. Martin, for his work on the Chalk Tertiary and Pleistocene succession in Sussex, and his valuable contribution to geological science as treasurer of the Geologists' Association for thirteen years, including the war years; Murchison Fund, to Dr. S. O. Agrell, for his work on the adinoles of Dinas Head, Cornwall, and his mineralogical observations on some basic open-hearth slags; a moiety of the Lyell Fund, to Dr. W. D. Evans, for his work on the Ordovician rocks of north Pembrokeshire, on air-borne dusts in collieries and on the Midland iron-ore of coalfields; another moiety of the Lyell Fund, to Dr. P. E. Kent, for his geological investigations in East Africa and in the United Kingdom.

## Royal Astronomical Society

THE Council of the Royal Astronomical Society has made the following awards: Gold Medal to Prof. Sydney Chapman, Sedleian professor of natural philosophy in the University of Oxford, for his contributions to geophysics and solar physics, and particularly to the theory of geomagnetic phenomena; Jackson-Gwilt Medal and Gift to Mr. Algernon Montague Newbegin, for his observations of solar prominences and sunspots during the past forty years.

## Institution of Mechanical Engineers

THE James Watt International Medal of the Institution of Mechanical Engineers has been awarded to Dr. Fredrik Ljungström of Sweden, for his outstanding contributions to the development of mechanical engineering, the most notable of which are the air preheater which bears his name and the steam turbine developed jointly with his brother, the late Birger Ljungström. The Medal is awarded every two years to an engineer who has achieved world-wide eminence in some branch of mechanical engineering.

## Engineering at University College, London : Prof. G. T. R. Hill

Prof. G. T. R. Hill retired at the beginning of the present academic session from the Kennedy chair of mechanical engineering at University College, University of London, which he had held since 1934. During the First World War, Prof. Hill was engaged in aerodynamic research and acted as observer during flight trials on new and experimental types of aeroplanes. Awarded a commission in the Royal Flying Corps in 1916, he was posted overseas to France, was awarded the Military Cross and promoted to the rank of captain. In 1917 he was posted as a flight commander to an experimental station of the Royal Aircraft Factory. In 1918 he was posted to the Air Ministry as deputy head of the section responsible for dynamics research. After demobilization in 1919, he worked with Messrs. Handley Page as chief test pilot and experimental engineer, until in 1922 he was awarded a senior studentship by the Commissioners of the 1851 Exhibition. Later, with the aid of a grant from the Aeronautical Research Committee, he completed the design of the tail-less aeroplane (Pterodactyl). This work was taken over in 1926 by the Westland Aircraft Works, whose staff he then joined, and thereafter with the aid of experimental contracts by the Air Ministry he developed a type of Pterodactyl for war purposes.

Prof. Hill's work has covered a wide field in applied science, involving problems in ballistics, hydraulics, optics, electricity, as well as metallurgy and mechanical engineering. As a lecturer at engineering societies, schools, Royal Air Force units and other bodies throughout Britain, Prof. Hill is known for the ever delightful lucidity by which he illustrates intricate problems connected with his special subject. In college he was a delightful colleague, always maintaining close interest in matters affecting staff and students, and his outstanding work in the University of London Air Squadron greatly helped to maintain contacts and the thrill of his earlier years. His associates throughout University College will miss his pleasing personality.

## Northern Ireland Ministry of Agriculture : Mr. D. A. E. Harkness, C.B.E.

Mr. D. A. E. Harkness, senior assistant secretary in the Northern Ireland Ministry of Agriculture, has been appointed secretary in succession to the late Dr. G. Scott Robertson. Mr. Harkness was acting secretary in the Ministry when Dr. Robertson was given leave to become the first director of agricultural production and research under the Food and Agriculture Organisation. He graduated in the University of Glasgow and became assistant to the professor of economics at Queen's University, Belfast, before joining the Northern Ireland Ministry of Agriculture in 1924 as chief of the Statistics and Intelligence Branch. In 1926 Mr. Harkness was appointed lecturer in agricultural economics at the Queen's University, a position which he held until shortly after his appointment as assistant secretary in the Ministry in 1936. He became senior assistant secretary in 1939.

## Committee on Interrelations of Pleistocene Research

In June 1947 a new committee, known as the Committee on Interrelations of Pleistocene Research, was set up under the Division of Geology and Geography of the National Research Council, Washington, D.C. This Committee, which stresses the fact that research in this significant field involves numerous disciplines, is under the chairmanship of Dr. Richard F. Flint, professor of geology, Yale University. Its objectives are : (*a*) to study the field of Pleistocene studies and to survey research in progress ; (*b*) to prepare a report on the various lines of research now being carried out ; and (*c*) to suggest problems that should be attacked, with special emphasis on those involving two or more disciplines. The list of members and the fields covered by each provide an indication of the effort being made by this group to achieve broad representation. The members are : Dr. Edward S. Deevey, jun., lecturer in biology, Yale University (biogeography) ; Dr. Loren C. Eiseley, professor of anthropology, University of Pennsylvania (anthropology and New World archæology) ; Dr. Claude W. Hibbard, associate curator of vertebrates, Museum of Palæontology, University of Michigan (vertebrate palæontology) ; Prof. Chauncey D. Holmes, professor of geology, University of Missouri (glacial erosion and sedimentation) ; Dr. Helmut E. Lansberg, deputy director, Committee on Geophysical Sciences, Joint Research and Development Board, Washington, D.C. (meteorology and climatology) ; Dr. Hallam L. Movius, jun., curator of palæolithic archæology, Peabody Museum, Harvard University (Old World archæology) ; Dr. Fred B. Phleger, jun., asst. prof. of geology, Amherst College (oceanography and sea-floor geology) ; Dr. Louis L. Ray, United States Geological Survey (glacial stratigraphy and alpine glacial geology) ; Dr. H. T. U. Smith, associate professor of geology, University of Kansas (eolian features, frozen ground and stream terraces) ; Dr. James Thorp, principal soil scientist, United States Dept. of Agriculture (soil science). This group is especially anxious to correspond and exchange reprints with foreign workers interested in various aspects of the Pleistocene, and to obtain information concerning research now in progress.

On April 5 and 6, 1948, the Committee held its first meeting, at which were discussed several measures looking towards closer co-operation among those working in the various fields that deal with the Pleistocene. It was decided to publish a series of articles in 1949 covering some of the major problems, which may be assembled in a single volume for distribution by the Division of Geology and Geography of the National Research Council. Plans were made to compile a map showing the distribution of the loess and wind-blown deposits of North America. It is felt that the ground-work has been laid for breaking down certain of the arbitrary divisions between the various disciplines, the existence of which has so badly hampered Pleistocene research up to the present (see also p. 186 of this issue).

## International Book Token Scheme

A scheme has been devised by Unesco to overcome foreign-exchange difficulties and so enable educational and scientific institutions in 'soft' currency countries to buy publications from 'hard' currency countries. Purchases will be made in the national currency of the countries concerned, and Unesco will supply the necessary dollars. The plan will operate for an experimental period of one year and is limited to 150,000 dollars worth of book coupons, which will be shared by eleven countries, including Great Britain. If it is successful, however, the scheme may be expanded to include all member

States of Unesco. The coupons may be used to buy books on education, science and culture, the importation of which is prohibited by importing laws. They can also be used for subscriptions to periodicals, for the purchase of individual volumes or issues and for the payment of photo copies. The coupons will be available in denominations ranging from 25 cents to 10 dollars. Other countries where the coupons will be on sale are: China, Czechoslovakia, France, India and Poland. In addition, a limited free distribution, financed by Unesco, will be made in Austria, China, Czechoslovakia, Greece, Hungary, Italy, the Philippines and Poland. The coupons of each participating country will be handled by its own national distributing body, and in Great Britain this function is being undertaken by Book Tokens, Ltd., 28/30 Little Russell Street, London, W.C.1, from whom all particulars may be obtained. It is pointed out that as the amount of dollars available is limited, coupons will be allocated on a priority basis, and the needs of educational, scientific and cultural institutions serving a large public will be given first consideration.

## Northern Advisory Council for Further Education

In March and April of 1947, the Minister of Education issued directions to local education authorities to prepare and submit schemes for further education and plans for county colleges. In Circular 133, containing directions for further education, the Minister reminded local education authorities that they are required when preparing their schemes to "have regard to facilities provided by other bodies and to consult such bodies and local education authorities for adjacent areas". The procedure for the consultations referred to in Circular 133 was discussed by the Northern Advisory Council for Further Education at its meeting in October 1947, when it was decided that the first step should be the preparation of an agreed draft by a committee consisting of the 'chief education officers' of the constituent authorities. Its report has now been prepared and was approved by the Council in November 1948. Adult education, county colleges, community centres and other kinds of further education were considered to lie outside the scope of the Committee, and its deliberations were confined to technical, commercial and art education as provided in the main colleges. Starting from the broad principle that each authority should be free to provide for its own residents up to the national certificate stage, provided that numbers justified this measure, the Committee has worked out a detailed programme in which technical education in the north-east area could function as an integrated regional scheme. Implementation of the recommendations in this report would do much to provide Great Britain with adequate numbers of the technically trained persons who are so urgently required. Copies of the report may be obtained from 43 Eldon Place, Barras Bridge, Newcastle-upon-Tyne, 1.

## Magnetic Field of the Sun

A recent paper by Prof. S. Chapman (*Mon. Not. Roy. Astro. Soc.*, 108, No. 3; 1948), with the title "Solar Magnetism and the Suggested Fundamental Magnetization by Rotation", deals with the difficulties in accepting the 'fundamental' hypothesis, recently revised by Blackett. According to this hypothesis, the general magnetic fields of the earth, the sun and of certain stars introduce a new fundamental property of rotating bodies which can be expressed by the formula $P/W = \beta G^{1/2}/2c$, $P$ being the axial component of the dipole magnetic moment, $W$ the angular momentum, $G$ the constant of gravitation, $c$ the speed of light, and $\beta$ a factor of the order unity (for the earth it is 0·3). It was pointed out by Bullard that the fundamental hypothesis seems to imply a downward decrease of intensity of the geomagnetic field within the earth, and measurements since made in South Africa and in England provisionally support the hypothesis (see *Nature*, **160**, 746; 1947; **161**, 462; 1948). Chapman develops the consequences of the hypothesis—in particular as to the nature of the internal fields of the earth and sun—basing his calculation on the density distribution given by Blanch, Lowan, Marshak and Bethe for the point convective model of the sun, and taking into account a non-uniform distribution of the angular velocity approximating to that given by Schwarzschild. The corresponding moment of inertia and angular momentum of the sun are calculated, and $\beta$ is estimated to be 2 if the sun's polar magnetic intensity is 50 gauss; but accepting Thiessen's recent value of 10 gauss, or less, $\beta$ cannot exceed 0·4, which is close to 0·3, the value of $\beta$ for the earth. The inferred intensity at the centre is a few thousand gauss, similar to that of sunspot magnetic fields. The fundamental theory seems incapable of explaining the existence of the intense sunspot magnetic field, and this weakens the case for postulating a new fundamental property of matter to explain the general magnetic field. It is admitted, however, that it is remarkable, and may be profoundly significant, that the ratios of the values of $P$, extending over a considerable range, for the earth, the sun, and certain stars, to the associated values of $W$, differ by less than one factor of ten.

## Suggestions for Science Teachers in Devastated Countries

Unesco has recently published an illustrated booklet showing how teachers lacking elementary scientific equipment can make apparatus from simple everyday materials. The booklet has been prepared by Mr. J. P. Stephenson, science master at the City of London School, who first explains how science teaching can be commenced without the use of apparatus and then shows how equipment for experiments in astronomy, meteorology, heat, light, magnetism, electricity, chemistry and biology can be improvised from materials such as wood, glass-tube, wire, nails, bottles and other household articles.

A note is also included on the use of visual aids in science teaching together with a description of recent laboratory materials, such as plastics and alloys, and a section on laboratory receipts, charts and logarithm tables. The booklet is being distributed free by Unesco to schools in Greece, Poland, Czechoslovakia, Austria, Hungary, Italy, China and the Philippines, with the hope that it may lead to further improvisation in apparatus for elementary science teaching. It should be interesting later to see what influence this booklet has on the teaching of science in the recipient countries.

## Paper Supplies for Books

In a written reply to a question in the House of Commons, the President of the Board of Trade states that from March 6 the licensing arrangements for paper will be considerably simplified. As a result, paper for books, stationery, boxes, cartons and many minor uses should be freely available without in-

dividual licences or quotas up to the full extent of the limits set by the supply position. Bulk licences will be given to paper makers and importers authorizing them to deliver or convert any paper produced or imported by them, with certain specific exceptions, which include newsprint, insulating cable paper, certain classes of paper used for packaging, etc. The use of paper for newspapers and periodicals will still be restricted by the provisions of the Paper Control Orders. The improvement in the supply position from non-dollar sources, it is stated, has made these modifications possible, and the need to maintain waste paper salvage at the highest possible level remains as great as ever.

## Symposium on Animal Speciation

A SYMPOSIUM on "Ecological and Genetic Factors of Speciation in Animals" was held by the Istituto Italiano di Idrobiologia, Pallanza (Novara), Italy, during July 29–August 2. The meeting was sponsored by the Consiglio Nazionale delle Ricerche (Italian National Research Council), whose general secretary, Dr. A. Morelli, opened the symposium, which was attended by thirty-four biologists. Papers were read by: E. Baldi, Pallanza (isolation mechanisms in populations of plankton freshwater crustaceans); M. Benazzi, Pisa (genetic-systematic studies on Triclades); F. G. Brieger, Piracicaba (heterosis in population-genetics and evolution); H. Burla, Zurich (ecology of *Drosophila* species of Switzerland); U. D'Ancona, Padua (Nemi's Daphniæ during twenty-five years of observations); A. Dreyfus, São Paulo (sex-ratio in hybrids and its interpretation by the study of salivary chromosomes); M. Galgano, Florence (ecological and genetic factors in the sexual cycle of amphibians); J. B. S. Haldane, London (importance of disease in evolution and speciation); J. Heuts, Louvain (ecological and genetic factors in the speciation of the fish *Gasterosteus aculeatus*); F. Mainx, Vienna (chromosomal races of the Agromyzine *Liriyomiza*); B. Rensch, Münster (histological transformations by change in body size); H. Spurway-Haldane, London (comments on Vavilov's law of homologous variation); V. Tonolli, Pallanza (isolation and stability of high-mountain Diaptomid populations); L. Trevisan, Pisa (evolution of the elephants during the Quaternary). Prof. Th. Dobzhansky, of Columbia University, New York, introduced the theme for discussion, and at the end of the meeting summed up the proceedings. The papers will be published in a special volume, edited by the Consiglio Nazionale delle Ricerche.

## The Night Sky in February

FULL moon occurs on Feb. 13d. 09h. 08m., U.T., and new moon on Feb. 27d. 20h. 55m. The following conjunctions with the moon take place: Feb. 13d. 22h., Saturn 3° S.; Feb. 23d. 23h., Jupiter 5° N.; Feb. 25d. 07h., Mercury 6° N.; Feb. 26d. 15h., Venus 4° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Venus on Feb. 10d. 08h., Mercury 4° N. Mercury sets less than half an hour after the sun on Feb. 1 and is in inferior conjunction on Feb. 2. At the middle of the month the planet is stationary and rises an hour before sunrise, but it is not favourably placed for observation during February. Venus is a morning star, rising at 6h. 56m., on Feb. 1 and 14, and at 6h. 40m. towards the end of the month, but is then too close to the sun for observation. Mars is still too close to the sun for favourable observation. Jupiter rises at 6h. 35m., 5h. 55m. and 5h. 08m. on Feb. 1, 14 and 28, respectively, and can be seen, but not favourably, for a short time in the eastern sky. Saturn is in opposition to the sun on Feb. 21 and is visible in the constellation of Leo Major, a little east of Regulus, during the night. Occultations of stars brighter than magnitude 6 are as follow: Feb. 3d. 21h. 13·4m., $e$ Pisc. (*D*); Feb. 4d. 20h. 43·4m., 54 Ceti (*D*); Feb. 15d. 22h. 47·1m., $\eta$ Virg. (*D*); Feb. 15d. 23h. 34·3m., $\eta$ Virg. (*R*). *D* and *R* refer to disappearance and re-appearance, respectively, and the latitude of Greenwich is assumed.

## Announcements

THE Committee of Privy Council for Agricultural Research has appointed Prof. F. T. Brooks, who has recently retired from the chair of botany in the University of Cambridge, to be a member of the Agricultural Research Council. This is Prof. Brooks' second term of office as a member, his first being during 1941–46.

THE Swiney Prize for 1949 has been awarded, on the recommendation of a joint committee of the Royal Society of Arts and the Royal College of Physicians, to Prof. John Glaister, of the University of Glasgow, for his work "Medical Jurisprudence and Toxicology". This is the second occasion on which Prof. Glaister has received the Swiney Prize, it having been awarded jointly to him and Prof. J. C. Brash in 1939 for their book "Medico-Legal Aspects of the Ruxton Case". The Prize, which is offered alternately for medical and general jurisprudence and consists of a £100 silver cup and money to the same amount, is awarded on every fifth anniversary of Dr. George Swiney's death on January 21, 1844.

MR. A. L. BACHARACH has been appointed to the staff of the Public Relations Director, Glaxo Laboratories, Ltd.; his long scientific and editorial experience will thus be available to assist all sections of the Company's public relations organisation. Dr. W. F. J. Cuthbertson will succeed him as head of the Nutrition Unit, Research Division, of Glaxo Laboratories, Ltd.

THE date for the receipt of applications for the Nuffield Foundation Research Fellowship in Extraction Metallurgy has been put forward to March 31, 1949. The Fellowship will be tenable at the Royal School of Mines, London, for a period of up to five years, and the funds available are sufficient to provide a salary of £1,200–£1,500 a year, as well as some £2,500 a year for assistants and apparatus. Applications should be sent to the Secretary, Institution of Mining and Metallurgy, Salisbury House, London, E.C.2.

REFERRING to the communication "Occurrence of *Acanthocephalus ranæ* Schrank. in Great Britain" (*Nature*, 162, 1001; 1948), Dr. N. B. Eales, of the University of Reading, writes: "Mr. R. Phillips Dales has recorded the occurrence of *Acanthocephalus ranæ* from the duodenum of frogs from either Cornwall or Surrey. We have also obtained this parasite from frogs caught locally during 1948. It is therefore not improbable that the specimens at Queen Mary College came from the frogs in the neighbourhood of London."

ERRATUM. In the communication "Relationship Between the Average Carcase Weight of Rams, Ewes and Lambs" (*Nature*, January 15, p. 100), for "$R + E = \Pi L$", read "$R + E = \pi L$".

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Disintegration of Boron-10 by Protons

THE Atomic Energy Research Establishment, Harwell, has recently produced a number of separated stable isotopes in milligram quantities. The availability of such isotopes has already enabled new nuclear reactions to be discovered, and old ones to be confirmed. In this and a later communication we wish to report on some work of this nature with boron and magnesium.

In the work with boron we have observed the α-particles expected in the reaction[1]

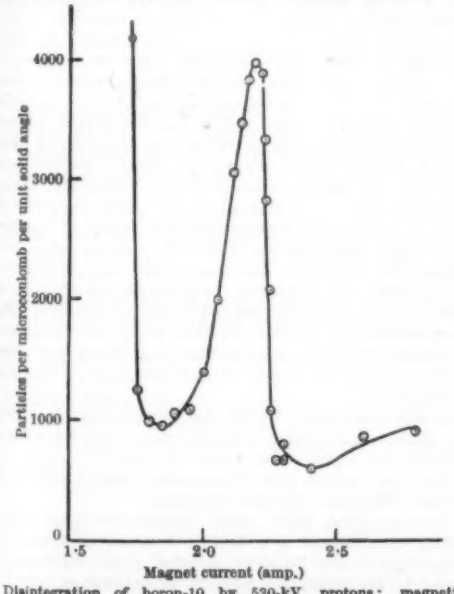
$$B^{10} + H^1 \rightarrow Be^7 + He^4 \qquad (1)$$

by using the magnetic analyser and photo-electric multiplier described in a previous communication[2]. Short-range α-particles from the disintegration of boron-11 were eliminated by using a target of separated boron-10. The accompanying graph shows the number of particles counted as a function of current through the analyser coils, for a proton energy of 530 kV.; the α-particle group from reaction (1) is clearly resolved from the scattered protons. The yield of α-particles was found to increase smoothly as the proton energy was varied between 400 and 800 kV.

The energy of the α-particles was measured by putting an absorption cell with a 2-mm. mica window between the analyser and the fluorescent screen, and finding the pressure in the cell at which the particles were cut off. This was compared directly with the cut-off pressure for the α-particles from the reaction[3]

$$Be^9 + H^1 \rightarrow Li^6 + He^4, \qquad (2)$$

for which the $Q$-value was taken to be 2·074 MeV. The difference in extrapolated range of the α-particles from reaction (1) at 630 keV. proton energy, and from reaction (2) at 860 keV., was found to be 0·35 ± 0·01 cm. of air; if the difference in straggling of the two groups is neglected, this gives a mean range of 0·56 ± 0·01 cm. for the α-particles from reaction (1). The corresponding energy release is 1·04 ± 0·06 MeV., using the Cornell range velocity curve[4]. This is to be compared with the value of 1·15 MeV. predicted from the masses[5].




Disintegration of boron-10 by 530-kV. protons; magnetic analysis of particles from the target

As a check on this energy release the magnet current at which the α-particles from reaction (1) were observed was accurately determined. By comparing this with the current necessary for the observation of other known α-particle groups, including that from reaction (2), an energy release of 1·05 ± 0·07 MeV. in reaction (1) was obtained, in good agreement with the result from the range measurement.

It is possible that the beryllium-7 nucleus is formed in an excited state in reaction (1), but we have been unable to find any evidence of α-particles corresponding to transitions to the ground-state in numbers exceeding 10 per cent of the main group at the particular angle of observation (83° with the incident protons).

We wish to thank Sir John Cockcroft and Dr. W. D. Allen and members of his group at the Atomic Energy Research Establishment, Harwell, who supplied the boron-10 target used. One of us (J. M. F.) is indebted to the Australian Council for Scientific and Industrial Research for a studentship.

W. E. BURCHAM
JOAN M. FREEMAN

Cavendish Laboratory,
Cambridge. Nov. 19.

[1] Roberts, Heydenburg and Locher, *Phys. Rev.*, **53**, 1016 (1938). Rumbaugh, Roberts and Hafstad, *Phys. Rev.*, **54**, 654 (1938).
[2] Freeman and Baxter, *Nature*, **162**, 696 (1948).
[3] Rosario, *Phys. Rev.*, **74**, 304 (1948).
[4] Holloway and Livingston, *Phys. Rev.*, **54**, 18 (1938).
[5] Bethe, "Elementary Nuclear Theory", 124 (Wiley, New York).

## Specific Ionization of Fast β-Particles in a Mixture of Air and Ethyl Alcohol – Water Vapour

Curran and Reid have given an account[1] of their investigations on the primary ionization of β-particles in mixtures of argon and ethyl alcohol vapour. I have carried out some experiments on the specific ionization of fast β-particles in a mixture of air and ethyl alcohol – water vapour[2].

A detailed study was made of the influence on the ionization in air of the mixture of ethyl alcohol and water generally used as a source of vapour in the Wilson cloud chamber. To this end both the probable and the primary ionization in air were determined at three pressures, namely, at 1, ½ and ¼ atmosphere. Assuming the specific ionization in pure air in this region to increase linearly with the pressure, it is possible to deduce from the observed values the specific ionization in the vapour-mixture.

The experiments were made for β-particles of various energies, namely, with a $\rho H$ of 1,200, 1,600, 2,000 and 2,400 gauss/cm. The mean specific ionization in ethyl alcohol – water vapour (liquid 60/40 by volume) at 0° C. and 1 cm. mercury pressure, at the energies stated, was 3·86, 3·24, 2·71, 2·45 ion pairs/cm. for the probable ionization and 2·22, 1·68, 1·35, 1·18 ion pairs/cm. for the primary ionization respectively.

It follows from these figures that the mean specific primary ionization for a β-particle of energy 0·4 MeV.

in an ethyl alcohol – water vapour mixture at 0° C. and 76 cm. mercury pressure amounts to about 90 ion pairs/cm., a number which is somewhat higher than the value of 79 ion pairs/cm. for alcohol vapour found by Curran and Reid and determined by the method of placing two counters in a spectrograph.

W. J. BEEKMAN

Physical Laboratory,
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Nov. 14.

[1] Curran, S. C., and Reid, J. M., *Nature*, **160**, 866 (1947).
[2] Beekman, W. J., *Physica*, **12**, 534 (1946).

## Directional Correlation between Successive Internal-Conversion Electrons from Tantalum-181*

HAFNIUM-181 decays with a 48 day half-life to a 20-microsecond metastable state[1] of tantalum-181. From this, two γ-rays are emitted in cascade, with internal conversion coefficients $N_e/(N_e + N_\gamma)$ approximately 0·6 and 0·06 [2]. We wish to report some measurements on the directional-correlation between these successive conversion electrons.

2 mgm. of finely divided hafnia, irradiated with slow neutrons in the Harwell pile to give hafnium-181, was used as a source. Self-absorption in the source of the softer conversion electrons was appreciable. Four Geiger–Müller counters with 2·3-mgm./cm.² windows were placed around the source, each 6 cm. away from it. They were arranged as two pairs to measure the instantaneous coincidence-rates $C$ for two angles at the same time. Angles of 90° and 180° have been used, with an angular resolution of ± 8°. Each counter fed very short pulses (0·3 microsecond) into its coincidence unit, so that delayed coincidences were practically eliminated and the correction for random coincidences was small. The anisotropy was found to be

$$\frac{C\,(180°) - C\,(90°)}{C\,(90°)} = -0{\cdot}32 \pm 0{\cdot}08.$$

Check experiments on secondary electrons from unconverted γ-rays showed that effects from these were small.

Extensions of such experiments are being considered, as well as the theoretical implications regarding the multipolarity of the transitions involved and spins of the corresponding nuclear states.

A. H. WARD
D. WALKER

Physics Department,
University,
Edgbaston, Birmingham 15.
Nov. 11.

[1] De Benedetti, S., and McGowan, F. K., *Phys. Rev.*, **70**, 569 (1946).
[2] Bunyan, D. E., Lundby, A., Ward, A. H., and Walker, D., *Proc. Phys. Soc.*, **61**, 300 (1948).

## A New Phenomenon in the High-Pressure Mercury Vapour Discharge

THE mechanism of the positive column of the high-pressure mercury vapour discharge appears to be now well understood[1]. It has been a basic assumption in all the theoretical work—and this has been borne out by general experience of the behaviour of the discharge—that the positive column is substantially uniform in all properties along the whole of the distance between the electrodes, at least to within less than a millimetre from the discharge terminations. It is true that there are some exceptions: the column often tends to contract near the electrodes, and in long vertical burning tubes this effect is more marked at the lower end. This contraction is not difficult to understand, and its accentuation at the lower electrode is due to the higher density there compared with that at the upper end of the tube. It is true also that very close to the cathode small intense bright spots may often be seen[2], but it has always seemed likely that this was associated with a purely surface effect on the electrode; and there has been no evidence to suggest that in the high-pressure condition any appreciable degree of axial non-uniformity could be produced.

For some time we have been making observations on discharges in mercury vapour at pressures of the order of 5 atmospheres, and with arc-lengths of the order of 10–20 mm., which are somewhat surprising in view of this long-accepted background.

Bright region in the neighbourhood of the cathode of a high-pressure mercury-vapour discharge showing intense barium spectrum

If a small amount of a relatively easily ionized vapour, such as sodium or barium, is evaporated into the positive column of such a discharge, at high loadings (of the order of 1 kW. per cm. of arc), a large intense region may be produced extending from the cathode over a substantial part of the distance between the electrodes. The accompanying photograph—which was taken through a Wratten 25 filter with a *P*1200 plate—shows the bright region produced in the neighbourhood of the cathode of a D.C. discharge, by the addition of a small quantity of barium vapour to the high-pressure mercury vapour. This bright area has fairly clearly defined edges and radiates an intense Ba spectrum with—less strongly—that of $Ba^+$. Its luminance is some 40,000 Sb., which is about twice that of the remainder of the arc. The phenomenon in its present form seems to be mainly associated with the cathode function, since it appears at this electrode whatever the position of burning of the arc.

Another property which the photograph incidentally shows is that the intense region can be preferentially deflected in a magnetic field.

There are indications that similar phenomena occur in the rare gases at high pressures.

The fact that quite small quantities of an easily ionizable substance are able profoundly to affect the properties of the positive column is not very unexpected; but that a cathode phenomenon of this magnitude can be so produced is of considerable

theoretical interest and warrants further study. It is hoped shortly to publish this work in detail.

V. J. Francis
G. G. Isaacs

Research Laboratories,
The General Electric Co., Ltd.,
Wembley.
July 27.

[1] See, for example, Elenbaas, W., *Phil. Res., Rep.*, **2**, 20 (1947). Francis, V. J., *Phil. Mag.*, **37**, 433, 653 (1946), and references given therein.
[2] Nelson, E. H., *G.E.C. J.*, **14**, 73 (1946). Bourne, H. K., *B.T.H. Act.*, **19**, 181 (1947).

## Radial Patterson Distribution Functions

It has been indicated in a previous paper[1] how a comparison between the structure factors ($F(h,k,l)$) resulting from a given molecular configuration, and those actually observed by experiment, can be effected by comparing the Patterson maps resulting from the observations and from the proposed molecule. This suffers the disadvantage of requiring a knowledge, not only of the intra-molecular configurations, but also of the positional relationships between the molecules themselves in the unit cell. Another approach is suggested by a result obtained recently[2]. Since the Patterson synthesis, in a certain neighbourhood of the origin, depends mainly upon the intra-molecular configuration, a possible basis of comparison between a postulated molecular structure and a set of observations would lie in an investigation of the distribution functions resulting from each in *Patterson* space.

It is simple to obtain the radial Patterson function of a given molecule by the processes of elementary geometry. We now investigate very briefly the technique for deriving the same function from the observed $|(F(h,k,l)|^2$ values.

For a radially symmetric function $T(R)$, the corresponding radially symmetric function in the reciprocal space is

$$g(r) = 4\pi w \int_0^\infty R^2 T(R)\,[(\sin 2\pi.rR)/(2\pi.rR)]\,dR,$$

where $w$ is the total weight of $g(r)$ and $T$ is scaled to value unity at the origin. For a cylindrically symmetric function $T(RZ)$, the corresponding function in the reciprocal space is[3]

$$g(rz) = 2\pi w \int_{-\infty}^{\infty}\int_0^\infty RT(RZ)\,J_0(2\pi rR) \exp(-2\pi izZ)\,.\,dRdZ.$$

Hence the three-dimensional radial Patterson function for a unit cell of volume $V$ may be written

$$g_3(r) = (1/V)\sum_s |F(h,k,l)|^2 \sin(2\pi rR_{h,k,l})/(2\pi rR),$$

where $1/R_{h,k,l}$ is the spacing of the plane $(h,k,l)$. The two-dimensional radial Patterson function for a unit cell of volume $V$ may correspondingly be written

$$g_2(r) = (1/A)\sum_s |F(h,k,o)|^2 J_0(2\pi rR_{h,k,o}).$$

Applications of the above methods to crystalline powders have been pointed out elsewhere[3], but we wish to remark here their special suitability to work in proteins. In this field a number of theories have been advanced for the structure of single molecules, and any check has been rendered difficult since it requires, not only a knowledge of the single molecule, but also of the relationship which this bears to its fellows in the unit cell. The present technique may permit a first comparison to be made without any consideration of intermolecular structure and with only limited computations. This is important since it will enable certain structures to be ruled out immediately. We wish to emphasize, however, that it can never establish the correctness of a given structure, but only its right to inclusion in the general class of possibilities.

Andrew D. Booth

Birkbeck College,
London.

Dorothy Wrinch

Smith College,
Amherst, Mass.
July 27.

[1] Booth, A. D., and Wrinch, D., *J. Chem. Phys.*, **15**, 416 (1947).
[2] Wrinch, D., "Fourier Transforms and Structure Factors", A.S.X.R.E.D. Monograph No. 2, 10 (1946).
[3] Booth, A. D., *Trans. Farad. Soc.*, **44**, 37 (1948).

## A Mechanical Calculating Machine for X-Ray Structure Factors

A large mechanical machine for calculation of X-ray crystallographic structure factors has now been completed in our laboratories and is running satisfactorily. The machine is of a tide-predictor type, and it deals with up to 24 harmonic components at a time.

The expression calculated is

$$F(hkl) = \sum_i f_i \cos 2\pi (h x_i + k y_i + l z_i).$$

During the calculation, for example, $h$ and $k$ are kept constant and the machine calculates $F$ for all required $l$ values at one setting. If there are $N$ atoms per unit cell, $N$ harmonic units are switched on; each unit has a phase dial on which is first set the value $h x_i + k y_i$. The values $z_i$ are set on a multiplier bar, which at each stroke adds these through a clutch to the values on the dials with an accuracy better than 1 : 1,000. After $l$ strokes, the dials thus read $h x_i + k y_i + l z_i$. Their angles are transferred to cosine arms, each of length $f_i$, the results of which are added together by means of a pulley belt differential with an accuracy better than 0·2 per cent of $F(000)$. An output pulley indicates on two geared-down dials the resulting values of $F$. The calculation assumes that the variation of $f_i$ with index is the same for all the atoms; heavy atoms must thus be treated separately.

The machine has provision for calculation of Booth corrections[1] $\varepsilon$ from the derivatives of $R$. For this purpose the errors $F_o - F_c$ are copied from a drum and thus fed into the machine. The machine is run again, but with $\pi/2$ added to the angles of the phase dials of the harmonic units, so that their arms produce sines instead of cosines. There is an arrangement which multiplies these by $W(F_o - F_c)$. The weights $W$ are chosen according to the formula for $R$ used[2], and according to whether $x$, $y$ or $z$ co-ordinates are to be corrected. The products are summed up on the $\varepsilon$ dials for all $l$. After completing the run, the $\varepsilon$ dials read the corrections by which the co-ordinates should be altered to decrease $R$. The cycle of calculations is represented in Fig. 1.

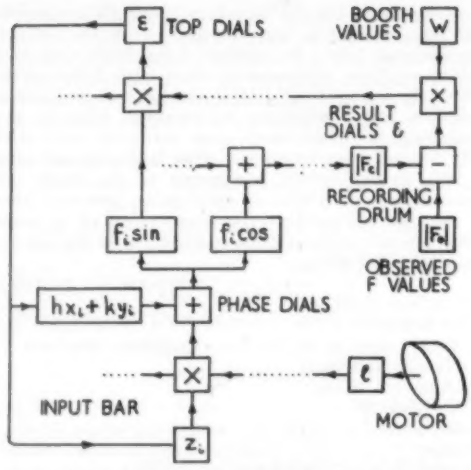


Fig. 1. Calculation cycle of the machine, using Booth's method of steepest descents

The machine is electrically driven, and the drive is automatically controlled, stopping after completion of a predetermined sequence of operations. Taking into account the setting times, it is about thirty times faster than manual methods. The output is of sufficient power to drive a registering pen mechanism. If desired, absolute values can be plotted automatically, each coded by means of a small kink in the curve; positive values have the kink upwards, negative downwards. A plot of $F$ values is shown in Fig. 2.

Although this machine was designed for calculation of structure factors, it can be used for Fourier synthesis of the electron density. As the lengths of the cosine arms are not readily adjustable, it is best to set all their lengths equal. The structure factors can then be represented as a sum of two vectors of unit length, differing in phase. The machine is run separately for each set of unit vectors and the results added. A unidimensional continuous electron density tracing is then obtained.

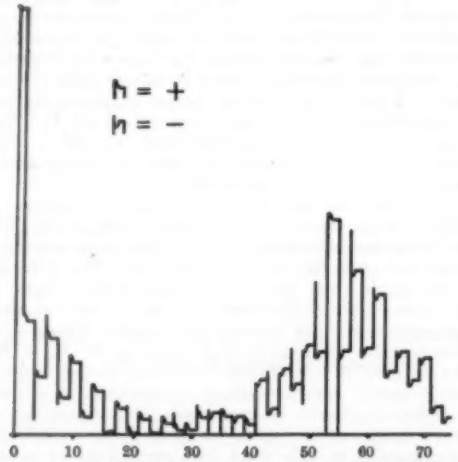


Fig. 2. Automatic recording of $F(00l)$ values of strontium laurate for $l$ up to 74 (odd values of $l$ absent). Scale: $F(000) = 1040$ electrons

'Ecofix' girders and 'Meccano' were used for parts where high accuracy was not required; this reduced the cost of the machine considerably and enabled us to build it in less than six months.

I wish to thank Mr. E. T. Sanders for machining the more accurate components.

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## Quadrupole Rotation-Vibration Spectrum of the Hydrogen Molecule

It is usually considered that molecular hydrogen does not have an infra-red rotation-vibration spectrum. However, such a spectrum may be expected as a forbidden transition made possible by the change of quadrupole moment during the vibration[1]. The predicted intensity of this spectrum is so low that a path of the order of 10 km. at atmospheric pressure is required to obtain it in absorption[1,2].

Using a pipe of 22 m. length and letting the light pass through it up to 250 times[2] at a pressure of 10 atmospheres, it was possible to obtain equivalent path-lengths up to 55 km. atmospheres. Under these conditions a number of lines of the 2–0 and 3–0 bands of the hydrogen quadrupole spectrum were indeed observed. The accompanying table compares the observed wave numbers with those predicted from the ultra-violet hydrogen spectrum[1]. The bands have only $S$, $Q$ and $O$ branches. Because of the small moment of inertia of the hydrogen molecule, only the first few lines of the $S$ and $Q$ branches are sufficiently intense for observation. No lines of the $O$ branches were found.

Wave-numbers of quadrupole lines of $H_2$

| Band | Line | ν (predicted) | ν (observed) |
|---|---|---|---|
| 2–0 | $S(0)$ | 8,403 | 8,406·36 |
| 2–0 | $S(1)$ | 8,601 | 8,604·26 |
| 2–0 | $S(2)$ | 8,782 | 8,785·54 |
| 2–0 | $Q(1)$ | 8,072 | 8,075·42 |
| 3–0 | $S(0)$ | 12,080 | 12,084·66 |
| 3–0 | $S(1)$ | 12,261 | 12,265·55 |
| 3–0 | $S(2)$ | 12,420 | 12,424·44 |
| 3–0 | $Q(1)$ | 11,760 | 11,764·96 |

The slight systematic difference of observed and predicted wave-numbers is due to the much lower wave-number accuracy in the vacuum ultra-violet and the lack of standards in this region. It is hoped to obtain improved rotational and vibrational constants of the hydrogen molecule in the ground-state from the wave-numbers of the quadrupole lines.

It appears that the spectrum here observed is the first example of quadrupole radiation in molecular spectra.

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[1] See Herzberg, G., *Astrophys. J.*, **87**, 428 (1938).
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## Radiation Pressure of Centimetre Waves

THE pressure exerted on a perfectly specular surface by a normally incident beam of electromagnetic waves travelling in free space can be calculated with the known formula

$$p = 2S/c,$$

where $S$ is the Poynting vector and $c$ the speed of light.

Many experiments have been performed in order to measure the pressure exerted by light waves, among which those by Amerio[1] seem to be particularly elegant. Lebedew[2] has found for the radiation emanating from the sun a pressure of the order of $10^{-3}$ dyne/cm.$^2$. The radiation pressure of electromagnetic waves produced by ordinary radio transmitters is smaller still and cannot be detected by direct means, since the wave-lengths involved are too large and the power does not reach adequate levels. The invention of new tubes (magnetrons) capable of generating high-power centimetre waves has made it possible to measure the radiation pressure of such radiation.

Using a 725 A.-type magnetron generating bursts of radio-frequency energy ($\lambda = 3$ cm., duration of each burst 1 μsec. with a recurrence of 1,000 cycles per second) of a mean value of 50 watts, the pressure exerted by the energy impinging on a surface of 2 cm.$^2$ (cross-section of rectangular wave-guide) is of the order of $10^{-3}$ dyne/cm.$^2$.

In order to detect such a pressure we have carried out the following experiments: before the mouth of a rectangular wave-guide excited by the above-mentioned magnetron, we placed the aluminium blade (6 cm.$^2$ cross-section) of a symmetrical torsion balance, having an arm 2 cm. long, protected by a glass cover. Observation was carried out in a rarefied atmosphere of 10 mm. mercury pressure approximately in order to minimize radiometer effects. The distance between the blade and the mouth of the wave-guide was never less than 4 cm. in order to avoid ionization under the action of the intense radio-frequency field.

Thus the blade was picking up only a fraction of the radiated energy. Different observations have been made at various points of the field. When intercepting the maximum radiation (approximately one fifth of the total available power), the balance indicates a torque of $10^{-3}$ dyne/cm. Diffraction phenomena explain this result, which is smaller than the theoretical torque corresponding to a force obtained by calculating the product of the pressure of the intercepted radiation by the effective cross-section of the blade.

In a theoretical paper[3], in which the propagation of the electromagnetic field in a wave-guide has been studied starting from relativistic considerations, we have demonstrated that within a (rectangular) wave-guide the pressure must be calculated with the formula:

$$p_g = 2Sv_g/c^2,$$

where $v_g$ is the group velocity, which is known to be less than $c$. We deduce from it a radiation pressure within the wave-guide less than the free space radiation pressure.

Measurements of $p_g$ are under way, and since $v_g$ is a calculable quantity, we hope to be able to obtain as final result the value of $S$ and consequently the generated power.

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[1] Amerio, A., *Nuovo Cimento*, **5**, série XVII–XVIII, 424 (1909).
[2] Lebedew, P. N., *Drud. Ann.*, **6**, 233 (1901)
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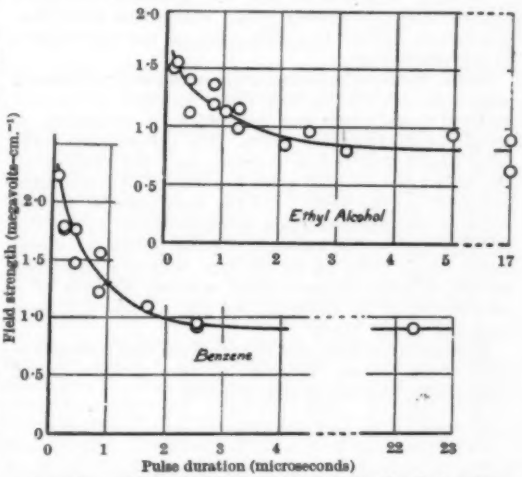
## Dielectric Strength of Liquids for Short Pulses of Voltage

EXPERIMENTS in progress here show a systematic increase in the dielectric strength of pure organic liquids as the duration of the pulse of voltage is decreased. In other words, between the instant of applying a field and the instant of breakdown there is a time-delay which becomes less as the field-strength is raised above the normal breakdown value. A suggestion of this delay can be seen in the early oscillograms of Rogowski, Flegler and Tamm[1].

We have used pure organic liquids of relatively simple molecular structure, both polar and non-polar. The accompanying graph shows the experimental relation between breakdown field-strength and pulse duration for benzene and alcohol. The experiments were performed at room temperature.




Dependence of dielectric strength upon pulse duration for benzene and alcohol

To avoid the considerable errors due to minute amounts of impurity, an apparatus has been constructed in which the liquid can be distilled *in vacuo* into the testing vessel. Single rectangular pulses of voltage are applied from a thermionic pulse generator to a pair of polished metal spheres immersed in the liquid and capable of being rotated from outside the vessel to present a fresh surface to the gap after a spark has occurred. We find that this apparatus reduces the 'spread' in the measurements, though a small proportion of the pulses still produce breakdown at field-strengths below the minimum value for consistent rupture, which we regard as the 'breakdown field-strength'. However, accidental lack of

ionization does not seem to play a major part in delaying breakdown, as in gases.

A high-speed single-stroke cathode ray oscillograph is used to observe and measure the pulses. We agree with Rogowski and his collaborators that the breakdown, when once started, becomes complete in about $10^{-9}$ sec.

A recent theory[2] of breakdown in amorphous dielectrics indicates that, above a certain critical field-strength, instability of the energy of the electrons in the conduction band occurs. It does not, however, go into the question of the time required to reach the state of instability from the moment of applying the field, neither does it deal with the events following the establishment of the unstable state. It is hoped that further experiments will show whether the time-delay we have found is associated with one or both of these possible causes.

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## Frictional Electrification

RECENT experiments on the so-called frictional electrification produced when dielectrics slide over conductors appear to throw light on the mechanism of its production.

Small cubes of ebonite or a measured volume of sand were allowed to slide down an earth-connected inclined metal plane and fall into a tin connected to an electrometer triode valve. The bodies were carefully discharged before starting, and the reading of the valve instruments gave a measure of the charge acquired in the slide. Above and parallel to the runway was another plate insulated from it, and by putting a potential between the two plates the specimens could slide in an electric field perpendicular to the sliding surface—there was an air gap of a centimetre or so between the top of the specimen and the upper plate.

It was found that this electric field had a considerable effect on the frictional charges produced, and that there was the simple relation

$$Q = -AX - Q_0$$

for any particular specimen, where $Q$ was the frictional charge for an electric force of $X$ volts per cm., $-Q_0$ was the frictional charge when sliding in zero field and $A$ was a constant ($X$ was taken as positive when the upper plate was at a positive potential to the lower).

Thus with ebonite or sand in zero field, a negative charge was produced; making the top plate positive increased the magnitude of this charge, while making it negative decreased it, and if sufficiently negative reversed its sign. In each case for a negative field, given by the value $Q_0/A$ for the substance, no charge was produced by the slide. This effect of an electric field gives a clue to the mechanism of frictional electricity.

The only way in which the dielectrics can acquire the charge is by the passage of electrons to or from the plate down which they slide. There is, thus, although the dielectrics are insulators, a leakage of charge over the contact surface, which continues until the external field is neutralized. If this were all, the curve connecting $Q$ and $X$ would be a straight line through the origin. The fact that it is a straight line but not through the origin proves that another field must also be present, due to a type of contact difference of potential between the dielectric and the plate. When there is no field, the passage of charge to neutralize this contact potential gives rise to the charges known as frictional electricity.

The effect of an external electric field, besides its theoretical interest, may have a practical use; because by the application of the appropriate field $Q_0/A$ (usually a moderate one of a few hundreds of volts per cm.) it is possible to prevent sliding particles getting any charge at all and thus get rid of certain dangers due to frictional electricity.

It would, however, be over-optimistic to expect a complete cure, because the phenomenon being a surface one, the magnitude of $Q_0$ and $A$, and therefore of $Q_0/A$, depends on the texture of the surfaces, their cleanliness, their dryness, their temperatures and so on; all of which may be varying with time. But even so, a considerable reduction in average frictional charges should be possible.

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## Action of Acetylcholine on Rabbit's Auricles in Relation to Acetylcholine Synthesis

WHEN the heart is removed from a freshly killed rabbit, the auricles can be dissected and put in a bath of Tyrode solution at 28° C. in which they continue to beat. The addition of acetylcholine to the bath slows the rate and diminishes the amplitude of the contractions.

After 24–36 hr., the auricles stop beating. The addition of acetylcholine to the bath at this point can restart the contractions, and further additions may increase the rate and amplitude. If the acetylcholine is removed without delay, the beat stops again; once, however, spontaneous activity is fully developed, removal of the starting dose does not arrest the beat, but it continues for an hour or more. Thus when the auricle stops beating, it appears to require acetylcholine in order to resume activity, which is then maintained. We have found a close correspondence between the functional state of the auricles and enzymic activity present in them. If an acetone-dried powder is prepared from auricles, it synthesizes acetylcholine in the conditions described for brain tissue by Feldberg and Mann[1]. The average figure for freshly excised auricles was 40 μgm. acetylcholine per gm. acetone powder per 75 min. We found that auricles which had stopped beating after 24 hr. in the bath lost most of their synthesizing power, the average figure being 15 μgm. per gm. Auricles which resumed activity after the addition of acetylcholine to the bath regained their synthesizing power, the average figure being 37 μgm. per gm.

The indication given by these figures of a connexion between activity in the living tissue and power to synthesize acetylcholine was borne out by

observations of the effect of acetylcholine on its synthesis. Addition of acetylcholine to a powder (5–80 μgm. per gm. powder) from fresh auricles reduced the acetylcholine synthesis to 30 per cent of its control value. On the other hand, addition of acetylcholine to a powder from stopped auricles increased the acetylcholine synthesis to more than twice the control value.

Thus the action of acetylcholine is inhibitor when applied to auricular tissue in which the rate of synthesis is high; it inhibits the beat and it depresses the synthesizing power. On the other hand, the action of acetylcholine is motor when applied to auricular tissue in which the rate of synthesis is low; it can start the beat and it augments the synthesizing power.

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## Failure of Antihistamine Drugs to Inhibit Hyaluronidase *in vitro*

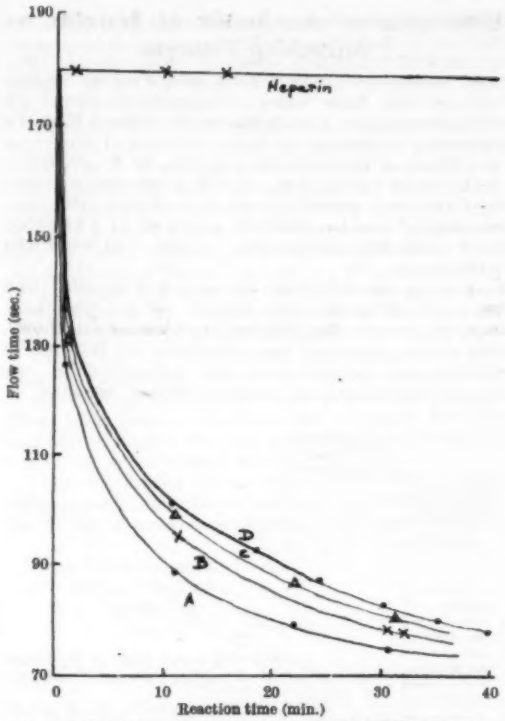
Mayer and Kull[1] have demonstrated that 'Pyribenzamine' and 'Antistin' counteract the spreading effect of hyaluronidase, and have claimed, therefore, that these antihistamine drugs exhibit a strong anti-hyaluronidase action. In view of the failure by Swyer[2], using an *in vitro* technique, to confirm a similar claim by Guerra[3,4] with respect to a supposed anti-hyaluronidase property of salicylates, it was decided to investigate the effect *in vitro* of various concentrations of some antihistamine drugs upon the hyaluronidase system.

Hyaluronidase preparations were obtained from rabbit and rat testis by a modification of the method of Kass and Seastone[5]. Enzymatic activity was measured in a No. 1 suspended-level viscometer. All estimations were carried out in a thermostat at 34° C.; this temperature was chosen because the work described here is part of a study of related problems in skin.

Viscosity reduction curves were obtained by a modification of the method of McClean and Hale[6], the flow-time of a mixture of 18 ml. buffer-substrate (4 vol. 0·12 per cent w/v aqueous hyaluronic acid and 1 vol. McIlvaine's citric acid–posphate buffer *p*H 7·0 containing 3·5 gm. sodium chloride/litre), 1 ml. buffer (or anti-histamine drug) and 1 ml. of testis extract, being measured at 2, 10, 20 and 30 min. after mixing. Prior to mixing, the solutions were filtered through a sintered glass funnel of porosity *G*4, and brought to 34° C.

Solutions containing 0·003, 0·033 and 0·33 per cent of (1) 'Antistin', (2) 'Benadryl', (3) 'Pyranisamine' and (4) 'Pyribenzamine', buffered so that the *p*H of each fell within the range 6·8–7·2, were tested for possible anti-hyaluronidase activity. In no case was there any evidence of significant inhibition of the enzyme. The latter was completely inactivated in the absence of chloride by the addition of 3·8 units of heparin per ml. reaction mixture. The effects of varying concentrations of 'Benadryl' upon the enzyme system are shown in the accompanying graph.

The above findings, therefore, show that, under our conditions, these drugs have no direct anti-hyaluronidase activity. Mayer and Kull, however, were careful to point out that their *in vivo* effects may be the result of a non-specific process. The work of Hechter[7] on the mechanism of the spreading effect of hyaluronidase in skin suggests, indeed, that this may be the case. Swyer[8] has shown that histamine enhances the spreading effect of hyaluronidase, and Mayer and Kull's findings might, therefore, be due to the action of these drugs on traces of histamine released during the intradermal injection of the spreading factor.




*A*, enzyme alone; *B*, enzyme in presence of 0·33 per cent 'Benadryl'; *C*, in presence of 0·003 per cent 'Benadryl'; *D*, in presence of 0·033 per cent 'Benadryl'

Our thanks are due to Messrs. Glaxo Laboratories, Ltd., for a gift of hyaluronic acid, to Messrs. Parke, Davis and Co., Ltd., Messrs. May and Baker, Ltd., and Ciba Laboratories, Ltd., for gifts of 'Benadryl', 'Pyranisamine' and 'Pyribenzamine', and 'Antistin', respectively. We would also like to thank Prof. R. H. S. Thompson for his help and encouragement.

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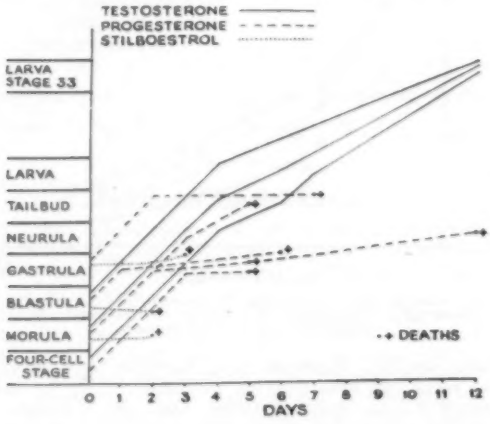
## Differences in the Action of Steroids on Amphibian Embryos

In addition to their actions on the sexual organs, the steroids have some characteristic effects on cellular division. Von Möllendorff[1] showed that the frequency of mitosis in tissue cultures of fibrocytes is influenced by alcoholic solutions of 1 : 10,000 to 1 : 5,000,000 testosterone. G. Töndury[2] demonstrated that abnormal mitotic divisions may be produced in amphibian ova by alcoholic solutions of 1 : 100,000 to 1 : 1,000,000 testosterone, œstriol, œstradiol and stilbœstrol.

A study of amphibian embryos has revealed that steroids may retard the rate of development to a varying extent. The following experiments deal with the actions of equal concentrations (1 : 100,000) of testosterone, progesterone and stilbœstrol on the developing amphibian embryo (*Triton tæniatus*).




Eggs in identical stages of development (four-cell, morula, blastula or gastrula) were put into jars of equal size, containing the same amount of artificial pond water (at 18° C.) in which the hormone had been dissolved. 84 specimens were used. Three sets of experiments were carried out, each starting with eggs in one of the embryonic stages mentioned above, and the rate of development was observed under a binocular microscope through thirty stages of development.

*Testosterone treatment.* Embryos in the four-cell stage develop into a tail-bud stage on the fifth day. The morula stage becomes a blastula in 24 hr. and a gastrula in another 24 hr. Normal young larvæ (stage 33) develop in a fortnight. Development from the blastula stage is normal.

*Progesterone treatment.* Embryos in the four-cell stage develop into gastrulæ on the fifth day but do not develop further; they die on the seventh to the ninth day, during the process of gastrulation (stage 10–12).

The rate of development of the morula is retarded; it develops into a blastula only after two days. Gastrulation occurs on the third day, but most of the gastrulæ die during the process of gastrulation. The few that develop into neurulæ die on the twelfth to thirteenth day.

A blastula develops into a gastrula in 24 hr., but usually dies without further development after four to five days. A few pass through the neurula stage and die later as tail-bud stages. Gastrulæ also pass through the neurula stage and die as tail-bud stages after seven days.

*Stilbœstrol treatment.* No further development occurs in embryos which began the experiment in the morula, blastula or gastrula stages, and they die after two to three days.

These experiments show that while testosterone does not affect the development of common newt embryos, stilbœstrol prevents all development. Treatment with progesterone prevents complete development, the embryo dying during gastrulation or in the limb-bud stages.

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## Acetate as a Possible Precursor of Ruminant Milk Fat, Particularly the Short-Chain Fatty Acids

The origin of the short-chain fatty acids ($C_4$—$C_{14}$) of milk fat has been the subject of much speculation; some believe they originate by degradation of long-chain acids[1,2], others that they are synthesized from carbohydrate[3]. Their occurrence in appreciable quantities only in the milk fat of herbivores, more particularly ruminants[4], may be significant in the light of the fact that considerable quantities of acetate are produced in the rumen and absorbed into the blood[5]. These considerations, together with the demonstration that the body can build fatty-acid chains from acetate[6], suggested in 1945 that acetic acid might be the precursor of a portion of the milk fat, especially the short-chain acids[7].

In 1946 a fruitless attempt[8] was made to verify this theory by intravenous infusion of acetate into lactating goats during inanition, when the short-chain acids of the milk fat are much diminished. These negative results, and others in the cow[9], were probably due to avid utilization of the intravenously administered acetate by the fasting tissues, for ex-

| | 0·017 *M* glucose | | | 0·02 *M* sodium acetate | | |
|---|---|---|---|---|---|---|
| | $Q_{O_2}$ | $Q_{acid}$ | R.Q. | $Q_{O_2}$ | $Q_{acid}$* | R.Q. |
| 6 Rats | − 8·7 ± 1·0 | + 2·0 ± 0·6 | 1·66 ± 0·07 | − 4·8 ± 0·3 | + 0·6 ± 0·2 | 0·75 ± 0·06 |
| 6 Goats | − 4·5 ± 0·3 | + 1·5 ± 0·2 | 0·85 ± 0·04 | − 6·2 ± 0·5 | − 4·2 ± 0·7 | 1·20† ± 0·08 |

37° C.; 95 per cent oxygen + 5 per cent carbon dioxide; Ringer-bicarbonate; pH 7·4.
* In the case of acetate a negative value for $Q_{acid}$ is a measure of substrate utilization.
† Significantly greater than unity ($P = 0·03$).

ample, the heart[10], so that adequate blood-levels were not maintained. *In vitro* experiments with mammary gland slices have now provided what we believe to be the first evidence in favour of the new theory of the origin of milk fat (see accompanying table).

Lactating mammary gland slices from all non-ruminants studied—rat[11], mouse, rabbit and guinea pig—have given a high respiratory quotient (measured as before[11]) in the presence of glucose, indicating the probable formation of fat from carbohydrate; on the other hand, the respiratory quotient for slices from the goat (and cow) is well below unity. With acetate as substrate, however, the situation is reversed, goat (and cow) gland now giving a respiratory quotient greater than unity, whereas the rat (and mouse) mammary gland do not appear to utilize acetate. The mammary tissue of the ruminant thus appears to be adapted for metabolizing acetate; and can not only oxidize it, but also, as indicated by the high respiratory quotient *in vitro*, can probably utilize it for fat synthesis, in this respect differing from other mammals, exemplified by the rat, which appear to require carbohydrate as substrate for fat formation. These results are consistent with the theory that in ruminants part of the milk fat is synthesized from acetate (this would explain the high udder respiratory quotient *in vivo*[9,11]); and if this is so, it seems very likely that the short-chain acids in particular arise in this way.

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## Criteria of Relationship between Plant Virus Strains

It is now generally recognized that cross-protective power in the host plant, and serological relationship, are two of the most satisfactory criteria for establishing relationship between plant viruses.

In spite of an early observation by Smith[1], it is usually considered that if two viruses are related strains, then one strain will protect a plant completely from infection by a second strain, provided that the plant is fully infected with the first strain before inoculation with the second.

In experiments in *Datura tatula* and tobacco with six mottle type and four ring-spot type strains of potato virus *X*, it was found that four of the mottle strains protected completely against all the ring-spot strains. However, with two strains of the mottle type (*B* from Duke of York potato[2] and *TBRX* from tomato[3]), necrotic local lesions and systemic necrosis developed following inoculation with any of the ring-spot strains used. However, symptoms were not as severe as in the healthy controls inoculated with the ring-spot strains.

The same set of ten strains was also examined by the serological cross-absorption technique. Six of the strains were indistinguishable by the method used. Two strains had been isolated from the same potato plant, one a symptomless and one a ring-spot type isolated from Salaman's $X^{A}$ culture[4]. These two strains were serologically indistinguishable, but possessed an antigenic fraction not possessed by any of the other eight strains. Thus, in this case, serological relationship was correlated with source of origin rather than symptom type.

*TBRX* and *B*, the two strains that did not give complete protection in the host, differed considerably in the serological tests from any of the other strains. They each had a strain-specific antigenic fraction and also shared a fraction not possessed by any of the other eight strains tested.

Thus, within the group of ten strains tested, there was a correlation between serological relationship and the degree of protection afforded in the host plant.

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Dec. 7.

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[2] Bawden, F. C., and Sheffield, F. M. L., *Ann. App. Biol.*, **31**, 33 (1944).
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## Infectious Chlorosis of Bananas in Colombia

A disease probably identical or closely allied to the 'infectious chlorosis' or 'heart rot' of bananas, of a virus nature, has recently been found in Cauca Valley, on the Pacific side of Colombia, South America, and is now being studied by the staff of the Agricultural Experimental Station of Palmira.

This is a new record of the disease, previously known, in America, in the islands of Guadeloupe and Haiti[1]. Australian and African records have been reported by Wardlaw[2].

This is also the second time that a virus disease of cultivated plants has been found in Hispaniola Island (Haiti and Dominican Republics) and Cauca Valley, Colombia. I have already published previous records of a disease of the cacao tree of the same geographical distribution[3].

The features of this banana disease coincide with the symptoms described by Magee, Morwood and Wardlaw, with the exception of linear spots (from midrib to margin), which are frequently brown or reddish, instead of chlorotic. This symptom appears to be correlated with the presence of anthocyanin pigment in the leaves.

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Dec. 8.

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## Head Presentation in Indian Chiroptera

More than a century ago, Daniell[1] described a head presentation during parturition in *Nyctalus noctula*. This record has been considered unique among bats, since later investigators have not been able to observe a similar birth. Breech presentation has been considered to be the usual rule in Chiroptera, following the observations of Rollinat and Trouessart[2] on *Myotis myotis* (called by them *Vespertilio murinus*), Sherman[3] on *Myotis austroriparius* and more recently by Wimsatt[4] on *Myotis lucifugus* among the Vespertilionidæ, and Blake[5] in a Phyllostomid bat (*Erophylla planifrons* ?).

Anyone who reads Daniell's account might be struck by the novelty of such a birth. I had opportunities of witnessing in detail parturition in the Indian short-nosed fruit bat *Cynopterus sphinx sphinx* (Vahl.), and Schneider's leaf-nosed bat *Hipposideros speoris* (Schn.), and in both a head presentation appears to be characteristic. Daniell's observations on *Nyctalus noctula* does not seem, therefore, to be unique, and since the two species reported above belong to the two different sub-orders of Chiroptera, extended observations may reveal further instances in which head presentation may be the rule.

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## Semi-Squamous Epithelial Layer in the Frog

After studying the existence of the semi-squamous epithelial layer in the gastric and intestinal mucosæ of different mammals, we were curious to know if a similar layer was present in the amphibians, and for the purpose of this investigation we chose the frog. In this animal it was found that the whole gastric and intestinal mucosæ, together with the gall bladder, were covered by this layer.

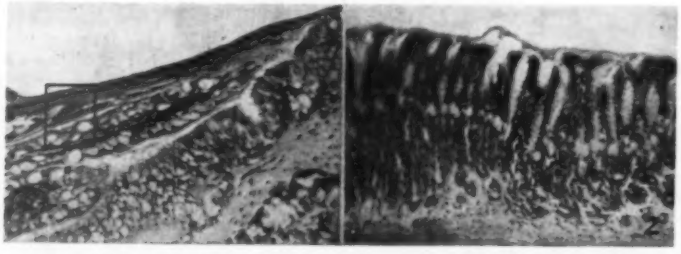

Fig. 1. Œsophagus of frog showing the ciliated tissue covered by the semi-squamous epithelial layer which contains a capillary. Fig. 2. Gastric mucosa of frog showing the layer

Fig. 3. High magnification of area outlined by rectangle in Fig. 1 showing details of the ciliated tissue covered by the semi-squamous epithelial layer containing a capillary

Investigations were also made to discover if the ciliated tissue in the œsophagus and pharynx of the frog was covered by the layer, as it has already been shown that the respiratory mucous membrane of mammals is protected by this structure. The same can be said of the ciliated tissue present in the Fallopian tubes, although this is rather more difficult to demonstrate because of the difficulty in opening the tubes without destroying the layer. It was logical to expect, therefore, that the semi-squamous epithelial layer should cover the ciliated tissue of the frog.

When this animal is used for the purpose of demonstrating the movement of the ciliated tissue, the layer is always removed beforehand as so-called mucus; but after carefully fixing the mucous membrane of the œsophagus and pharynx by the method of formalin vapour fixation, we were able to show not only that the ciliated tissue is covered by a similar layer to that found in the ciliated respiratory mucous membrane of mammals, but also that there were capillaries present at the top of this tissue.

It is borne in mind that these observations are against the accepted ideas of the physiological mechanism of protection by the ciliated tissue, but in the light of these investigations this supposed function obviously requires some revision.

My thanks are due to Prof. W. Schlapp, of the Department of Physiology, University of Manchester, for the supply of frogs, and to Mr. C. H. Butcher for technical assistance.

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## Taste Blindness of Japanese

It is well known that the strongly bitter taste of phenyl-thiourea is not noticed by some persons. It is said that 30 per cent of persons of white race do not recognize the taste. The result of tests on Japanese is given below:

| Age | No. of persons examined | No. of 'non-tasters' | Percentage of 'non-tasters' |
|---|---|---|---|
| 6–10 | 65 | 27 | 42 |
| 11–15 | 133 | 48 | 36 |
| 16–20 | 345 | 72 | 21 |
| 21–25 | 96 | 16 | 17 |
| 26– | 277 | 48 | 17 |
| Total | 916 | 211 | 23 |

The percentage of non-tasting persons is obviously smaller. It depends on the age, but is independent of the sex. In respect of inheritance, we have few data to discuss, but so far have found no 'tasting' child born of 'non-tasting' parents.

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## Composition of the Gum of *Sterculia setigera*: Occurrence of D-Tagatose in Nature

The method of paper partition chromatography provides a simple micro technique for the separation[1] and estimation[2] of mixtures of reducing sugars, such as result from the hydrolysis of complex polysaccharides. It is possible to obtain an indication of the identity of the separated sugars from a comparison of their *Rg* values[1,2] and their colour reactions when heated with a solution of naphthoresorcinol in 12 per cent hydrochloric acid[4,5], but in some instances the results are inconclusive. For example, fructose (*Rg* 0·13), sorbose (0·11) and tagatose (0·13) possess very similar *Rg* values and all give a characteristic red colour with the naphthoresorcinol reagent, and they cannot, therefore, be identified by these properties alone. The difficulty has been overcome by use of a column of powdered cellulose[3], on which it is possible to separate by partition chromatography sufficiently large quantities of the sugars to permit of their identification in the usual way by determination of physical constants and the formation of characteristic derivatives.

In a study of the gum exudate of the tropical tree *Sterculia setigera*, we have applied these methods to the analysis of the mixture of sugars produced by acid hydrolysis of the polysaccharide.

The gum shows exceptional stability to acids, requiring such drastic conditions for complete hydrolysis that the reaction is accompanied by much degradation of the sugars. Partial hydrolysis of the gum, however, gave, with little degradation, a mixture of sugars and a degraded material which contained the uronic acids. After hydrolysis the free sugars were separated from the uronic acid portion, the properties of which corresponded to those of a trisaccharide containing two D-galacturonic acid residues and a sugar residue, probably mainly L-rhamnose. The chief components of the non-acidic portion were D-galactose, L-rhamnose and a ketose, which, from its properties, could be fructose, tagatose or sorbose. A portion of the sugar mixture (1·6 gm.) was separated on a column of powdered cellulose using as the mobile phase a solution of *n*-butanol saturated with water. After removal of solvent, two of the fractions crystallized spontaneously, and pure specimens of D-galactose and L-rhamnose hydrate were obtained. D-Tagatose was obtained in crystalline form from an intermediate fraction after oxidation of the accompanying aldose to the aldonic acid, which was removed as the barium salt. This sample of D-tagatose from *Sterculia setigera* gum was identical with a synthetic specimen kindly sent to us by Prof. T. Reichstein. Its identity was confirmed by an X-ray comparison of the crystals of the naturally occurring and synthetic sugar. We are indebted to Dr. T. Malkin for these results.

| Fraction | Weight (in mgm.) | $[\alpha]_D$ in water | *Rg* values of sugars present | Sugars present |
|---|---|---|---|---|
| I | 15 | 12° | 0·385 | Ketose |
| II | 413 | 9·4° | 0·30 | L-Rhamnose |
| III | 145 | 8·0° | 0·17; 0·13 | Aldose and D-tagatose |
| IV | 373 | 34° | 0·17; 0·13; 0·07 | Aldose, tagatose and D-galactose |
| V | 640 | 80·5° | 0·07 | D-Galactose |

Fraction I contains a ketose which, in view of its high *Rg* value, is in all probability a methyl pentose derivative, and fraction III contains a small quantity of an unidentified aldose. The occurrence of D-galactose and L-rhamnose residues in a plant gum is not unusual, but the presence of D-tagatose in quantity is of particular interest since this ketose has not hitherto been reported as a constituent of any natural product. Its isolation illustrates the power of the new methods of analysis, and it is clear that re-examination of many plant and animal products will be required in order to ascertain whether sugars are present which have hitherto escaped detection.

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Sept. 4.

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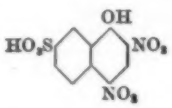
## Adsorption Complexes of α-Zinc Hydroxide

In numerous communications, Feitknecht has described the preparation and structures of the basic salts and hydroxide of zinc. Particular reference is made in this communication to the so-called α-form of zinc hydroxide ($Zn(OH)_2$), to which Feitknecht[1] has ascribed a partially random structure, consisting of an assemblage of parallel layers, packed together without any further regularity. The analogy with the structures of the natural clay minerals montmorillonite and halloysite suggested to one of us (D. M. C. M.) that it would be of interest to see if the α-hydroxide shows the same type of interlayer adsorption as these clays[2]. This appeared likely, because Feitknecht[3] had shown that certain anionic

dyestuffs are adsorbed on the α-zinc hydroxide, either by incorporating them in solution during the precipitation, or by shaking it with a solution of the dyestuff.

We have been able to prepare a stable complex of α-zinc hydroxide and the I.C.I. dye Naphthol Yellow



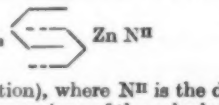

under well-defined conditions, which gives, in the unwashed state, a sharp basal spacing of 24·4 A. A single washing with either water or alcohol is sufficient to reduce this to an equally strong reflexion at 19·6 A. with four orders, which is stable to at least ten washings with alcohol or water, or even 0·001 *N* sodium hydroxide in alcohol. This is referred to below as the 'primary' complex.

Similar attempts to incorporate simpler non-ionized molecules (for example, glycerol) in the α-zinc hydroxide have failed. The analogy with the clay complexes thus appears to break down at this point.

However, it occurred to one of us (O. T.) that the more marked layer structure of the primary complex (clearly shown by the X-ray photographs) may make it more amenable to the adsorption of neutral organic molecules, thus forming 'secondary' complexes with increased basal spacings. Several such complexes, of which a small selection is listed in the accompanying table, have been investigated, using the same technique as has been used by MacEwan[2] with the clay mineral complexes. With the nitriles (except acetonitrile), a preliminary heat treatment was necessary to form the complex.

| Substance adsorbed | $d_{001}$ in A. | Δ in A. ($= d_{001} - 19{\cdot}6$) |
|---|---|---|
| Water | 30·7 | 11·1 |
| Methyl alcohol | 27·8 | 8·2 |
| Ethyl alcohol | 30·8 | 11·2 |
| Ethylene glycol | 29·6 | 10·0 |
| Glycerol | 30·1 | 10·5 |
| Acetonitrile | 23·7 | 4·1 |
| Propionitrile | 25·1 | 5·5 |

On the analogy of the constitutional formula assigned by Feitknecht[4] to the basic zinc chloride II, the zinc and carbon contents of the (α-zinc hydroxide)–(Naphthol Yellow) complex agree quantitatively, within the limits of experimental error, with the formula




(in Feitknecht's[5] notation), where $N^{II}$ is the divalent anion of the dye. A comparison of the calculated surface areas of the unit cell of α-zinc hydroxide and the planar dye molecule, together with the observed dye content of the primary complex, suggests that four layers of the dyestuff, lying flat, are held between consecutive layers of hydroxide. This is also in accord with the calculated thickness of the dye molecule, and the observed *c*-spacing of the primary complex.

The extra space taken up by the neutral organic molecules in the secondary complexes suggests that they form layers as in the clay mineral complexes, but the numbers of these layers appear to be different from those in the latter. This is probably due to differences in the actual mechanism of binding; in these 'secondary' complexes the additional molecules may be bound to the organic component of the primary complex rather than to the hydroxide layer. If this is so, it should be possible to prepare complexes presenting surfaces of different natures by employing anionic dyestuffs, the anionic portions of which vary in structure and lie within certain limits with regard to their size. The problem clearly requires a detailed examination, which is now being undertaken, and will form the subject of a later communication.

Prof. Feitknecht, who has seen this communication, informs us that he has since sent a communication entitled "Basische Salze organischer Säuren mit Schichtenstruktur" to *Experientia* (in the press).

We wish to thank Prof. W. Feitknecht for informing us, before publication, of certain of his results, and Messrs. I.C.I., Ltd. (Dyestuffs Division), for free gifts of materials. One of us (O. T.) wishes to thank the Department of Scientific and Industrial Research for a grant which has made his contribution possible.

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## Reduction Potentials of Conjugated Systems

WAZOWNEK and his collaborators have studied the reduction of conjugated systems at the dropping mercury electrode[1]. They have brought forward evidence to support the following mechanism:

$R + e^- \rightarrow R^-$ (reversible, potential-determining).
$R^- + e^- \rightarrow R^{=}$ (irreversible).
$R^{=} + 2H_2O \rightarrow RH_2$ (irreversible, fast).

This holds in the case of a molecule such as styrene, having a bond which is essentially double. In the case of aromatic molecules, however, the reversible, potential-determining step may consist in the addition of two electrons.

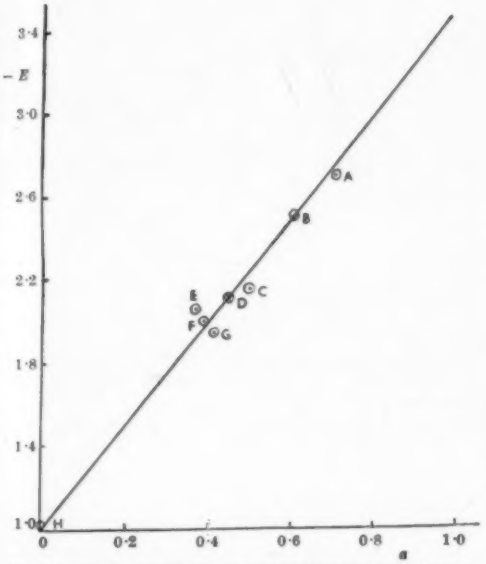
Hückel[2] has applied the molecular orbital method to a discussion of the alkali metal salts of aromatic compounds. He points out the qualitative relationship between the resonance energy in the lowest unoccupied molecular orbital (which may accept one or two electrons) and the ease of addition of the alkali metals. The present communication shows how this concept may be applied to discuss the reduction potentials of conjugated systems.

The reversible potential is given by

$$-nEF = \Delta H - T\Delta S,$$

where $\Delta H$ is the heat content and $\Delta S$ the entropy change, $n$ being the number of electrons involved. Now $\Delta H$ may be related to the energy required to place one or two electrons in the lowest unoccupied orbital of the molecule, and so there should exist a linear relationship between $E$ and $\alpha$, where $\alpha$ is the

coefficient of the molecular orbital resonance integral in the expression for the energy of the lowest unoccupied orbital. A plot of $E$ against $a$ is shown in the accompanying figure. The approximately linear relationship between $E$ and $n$ verifies the postulated mechanism. Further evidence may be obtained by considering the overall equilibrium between $R$ and $RH_2$. If this were the potential-determining process, there should exist a relationship between the potential and the difference in resonance energies of $RH_2$ and $R$. No such relationship exists.




The reduction potentials of some hydrocarbons as a function of $a$. The substances referred to are: $A$, diphenyl; $B$, naphthalene; $C$, stilbene; $D$, pyrene; $E$, tetraphenyl ethylene; $F$, 1 : 4 diphenyl butadiene; $G$, anthracene; and $H$, triphenyl methyl.

On the basis of the above theory, the difficulty of reduction of an isolated double bond and of benzene may be understood, for in these cases a very large negative potential would be required. In the former case polarographic reduction differs from catalytic reduction[3].

Reduction by dissolving metals may also be discussed on these lines. Two possible mechanisms exist in this case,

$$R + H^+ \rightarrow RH^+$$
$$RH^+ + 2e \rightarrow RH^-$$
$$RH^- + H^+ \rightarrow RH_2$$

as suggested by Burton and Ingold[4]; or

$$R + 2Na \rightarrow R^= + 2Na^+$$
$$R^= + 2BH \rightarrow RH_2 + 2B^-$$

as proposed by Ziegler[5]. In addition, there is the possibility in the former scheme of the consecutive addition of the electrons. Two problems arise in these cases, namely, the ease of reduction, and the products formed. The former may be discussed along the lines suggested above. For a discussion of the latter, the electron structure of $RH^-$ and $R^=$ will have to be examined. The position of addition of the protons will be determined by the charge distribution of the ions.

It is hoped shortly to publish a fuller account of this work.

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Aug. 10.

[1] Wasowuck *et al.*, *J. Amer. Chem. Soc.*, **64**, 1765, 2365 (1942); **68** 2541 (1946).
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## Electron Distribution in Substituted Styrenes Derived from Infra-Red Spectra

IN a recent communication[1], it was pointed out that the abnormalities in the physical properties and polymerization characteristics of vinyl mesitylene could be ascribed to steric hindrance by the methyl groups in the ortho positions; it was mentioned that a study of the infra-red spectra of the styrenes revealed differences that supported the hypothesis that this 'blocking' affected the electronic structure.

In the light of recent developments in the normal co-ordinate treatment of group vibrations[2], a more precise interpretation of the infra-red results may now be given. The key $\delta_{CH_2}$-band[3] in styrene lies at 913 cm.$^{-1}$. The shifts from this frequency in $m$- and $p$-methyl styrenes and in 5-vinyl-pseudocumene have values of $-5$, $-4$ and $-5$ cm.$^{-1}$ respectively; the shift in vinyl-mesitylene is $+12$ cm.$^{-1}$. The absolute magnitudes of $\delta_{CH_2}$ indicate that there is a resultant negative charge on the terminal carbon atom of the vinyl group in all five compounds, which will be associated with $m$-substitution in the phenyl nucleus. The methyl groups in the three compounds with negative increments give rise to a small additional negative charge over and above that due to conjugation with phenyl; presumably the normal effect found in propylene[3] is transmitted via the conjugated system. In vinyl mesitylene, the relative instability of planar structures inhibits the resonance effect, and, in spite of the presence of three methyl groups, the increment is positive, though the electron distribution is still such as to give rise to $m$-direction.

I wish to express my gratitude to Trinidad Leaseholds, Ltd., for allowing me access to the infra-red data used in this note.

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[1] Buck, F. R., Kennedy, G. T., Morton, F., and Tanner, E. M., *Nature*, **162**, 103 (1948).
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## Thermochemistry of Acetylene and Allylene and the Valency of Carbon

RECENTLY, Long and Norrish[1] have shown that when the energy associated with the tetravalent state of carbon is systematically taken into account it is possible to bring order into the thermochemistry of carbon. They support the value of 190 kcal. for the latent heat of sublimation of graphite into free atoms

at the lowest energy-level of tetravalence ($^4S$), and 125 k.cal. for the latent heat of sublimation into the divalent ($^2P$) state. Thus, the energy obtained in the $^4S \rightarrow {}^2P$ conversion is 65 kcal.

The purpose of the present note is to show that if we assume that in acetylene and derivatives there are two carbon atoms in the divalent state associated with each triple bond, and compute the heat of hydrogenation using this assumption together with the values of Long and Norrish, the result is in striking concordance with the experimental values.

*Heat of hydrogenation of acetylene to ethane.* Taking the value for the C—H bond energy in ethane[1], and writing °C for tetravalent carbon and C for divalent carbon, we have, assuming divalent carbon in acetylene:

$$\begin{matrix}\mathrm{CH}\\|\\\mathrm{CH}\end{matrix} = \begin{matrix}{}^{\circ}\mathrm{CH}\\|\\{}^{\circ}\mathrm{CH}\end{matrix} \qquad -130 \text{ k.cal.}$$

The first step consists in the excitation of the two carbon atoms:

$$\begin{matrix}{}^{\circ}\mathrm{CH}\\|\\{}^{\circ}\mathrm{CH}\end{matrix} + 4\mathrm{H} = \begin{matrix}{}^{\circ}\mathrm{CH_2}\\|\\{}^{\circ}\mathrm{CH_2}\end{matrix} \qquad +412 \text{ k.cal.}$$

$$2\mathrm{H_2} = 4\mathrm{H} \qquad -208{\cdot}2 \text{ k.cal.}$$

$$\begin{matrix}\mathrm{CH}\\|\\\mathrm{CH}\end{matrix} + 2\mathrm{H_2} = \begin{matrix}{}^{\circ}\mathrm{CH_2}\\|\\{}^{\circ}\mathrm{CH_2}\end{matrix} \qquad +73{\cdot}8 \text{ k.cal.}$$

The experimental value for this reaction is + 74·4 k.cal.

*Heat of hydrogenation of allylene to propane.* Again, using for the C—H bond energy in propane the value 102·8 k.cal.[1], and computing the heat of hydrogenation of allylene, we have:

$$\begin{matrix}{}^{\circ}\mathrm{CH_2}\\|\\\mathrm{C}\\|\\\mathrm{CH}\end{matrix} = \begin{matrix}{}^{\circ}\mathrm{CH_2}\\|\\{}^{\circ}\mathrm{C}\\|\\{}^{\circ}\mathrm{CH}\end{matrix} \qquad -130 \text{ k.cal.}$$

$$\begin{matrix}{}^{\circ}\mathrm{CH_2}\\|\\{}^{\circ}\mathrm{C}\\|\\{}^{\circ}\mathrm{CH}\end{matrix} + 4\mathrm{H} = \begin{matrix}{}^{\circ}\mathrm{CH_2}\\|\\{}^{\circ}\mathrm{CH_2}\\|\\{}^{\circ}\mathrm{CH_2}\end{matrix} \qquad +411{\cdot}2 \text{ k.cal.}$$

$$2\mathrm{H_2} = 4\mathrm{H} \qquad -208{\cdot}2 \text{ k.cal.}$$

$$\begin{matrix}{}^{\circ}\mathrm{CH_2}\\|\\\mathrm{C}\\|\\\mathrm{CH}\end{matrix} + 2\mathrm{H_2} = \begin{matrix}{}^{\circ}\mathrm{CH_2}\\|\\{}^{\circ}\mathrm{CH_2}\\|\\{}^{\circ}\mathrm{CH_2}\end{matrix} \qquad +73{\cdot}0 \text{ k.cal.}$$

The experimental value for this reaction is 71·1 k.cal.

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[1] Long and Norrish, *Proc. Roy. Soc.*, A, **187**, 337 (1946).

## Phase Characteristics of Exponential Functions

A PHASE relation familiar to students of applied mathematics exists between a simple harmonic oscillation and its derivative. Similar relations exist between exponential functions and their derivatives, but these do not appear to be well known, and are not described in any text-book I have been able to consult: reference is made in some text-books to the imaginary period of the exponential function.

The simplest relation of this type is expressed by

$$\dot{x}_2 = -kx_1,$$

where $x_1 = x(t_1)$, $x_2 = x(t_2)$, and $t_2 - t_1 = c$. Any exponential solution of this equation represents a subsidence, a damped oscillation, a harmonic oscillation, or an unbounded oscillation. The general solution is a sum of such components, and the value of $\varphi = kc$ determines which types may appear in it. In particular, there can be no unbounded component unless $\varphi > \pi/2$; no harmonic component unless $\varphi = \ldots -\frac{3\pi}{2}, \frac{\pi}{2}, \frac{5\pi}{2} \ldots$; and no steadily decreasing component unless $0 < \varphi \leqslant e^{-1}$.

When $e^{-1} < \varphi < \pi/2$, an expression of the form

$$x = X \exp(-At) \cdot \frac{\sin}{\cos}(Bt \pm \theta)$$

may be the solution. If then the interval $c$ is less than the periodic time $2\pi/B$, a derived expression is

$$\varphi = \frac{\gamma}{\sin\gamma} \exp\left(\frac{-\gamma}{\tan\gamma}\right),$$

where $\tan\gamma = B/A$.

The equation

$$\dot{x}_2 = -kx_1$$

may also be regarded as forecasting the behaviour of $x(t)$ for $t \geqslant c$ from its values for $0 \leqslant t < c$. For example, if $x = X$, for $0 \leqslant t < c$, successive integration shows that

$$x = X\left\{1 - \varphi\left(\frac{t}{c} - 1\right) + \frac{\varphi^2}{2!}\left(\frac{t}{c} - 2\right)^2 \ldots + \frac{(-\varphi)^{n-1}}{(n-1)!}\left[\frac{t}{c} - (n-1)\right]^{n-1}\right\},$$

for $(n-1)c \leqslant t < nc$.

This is steadily decreasing only if

$$\varphi \leqslant e^{-1},$$

a fact which is used in the following example.

An air-force formation has been operating $N$ aircraft, the maximum number that its resources suffice to maintain serviceable for an indefinite period, but holds in reserve, at $t_0$, $X$ serviceable aircraft over and above $N$. It is intended to operate for a period every serviceable aircraft held. There is evidence that the rate of change of serviceability, $\dot{x}_2$ at $t_2$, will be proportional to the difference $x_1$ between $N$ and $(N + x_1)$ the number operated at an earlier time $t_1$, so that $\dot{x}_2 = -kx$; if $k = 2$ per month, what may be the maximum value of $c = t_2 - t_1$ in months if there is to be no tendency for serviceability to fall below the continuously maintainable, $N$, level? Answer, $c$ must be $\geqslant e^{-1}/2$ or 0·184 month.

The class of equations to which the above illustrations belong has been discussed generally by H. R. Pitt[1], to whom, and to R. McKinnon Wood and G. Silyn-Roberts, I am indebted for unpublished notes.

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Thames House South,
Millbank,
London, S.W.1.
Nov. 17.

[1] *Proc. Camb. Phil. Soc.*, **40**, Pt. 3, 199 (1944), and 43 (1946).

# THE NATURE OF PENETRATING PARTICLES IN AIR SHOWERS

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## Introduction

EXTENSIVE air showers consist mainly of electrons and photons, but contain in addition a small percentage of particles more penetrating than electrons.

The nature of these particles was recently discussed by Auger, Daudin, Fréon and Maze[1]; and independently by Broadbent and Jánossy[2]. Both groups came to the conclusion that the penetrating particles cannot be mesons of the ordinary type. Auger's group suggested that the penetrating particles are 'λ-mesons', that is, charged particles of elementary charge and mass about 3 $m_e$. Broadbent and Jánossy put forward the suggestion that the penetrating particles are 'heavy electrons', that is, electrons of mass about 10 $m_e$. The two suggestions are, of course, identical; both were, however, based on somewhat indirect arguments. Recent experiments, partly reported at the Bristol Symposium held last September, give additional support to the λ-meson or heavy electron hypothesis.

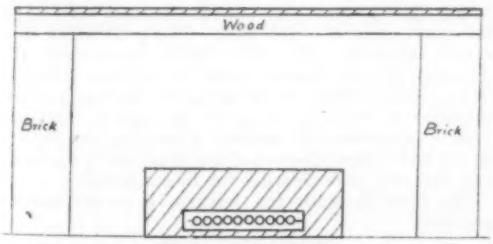
## Recent Experimental Evidence

Miss Chowdhuri reported at the Bristol Symposium the following experiment. Air showers were recorded by means of fourfold coincidences. The set consisted of three unshielded counters in a horizontal plane and a tray of shielded counters near by; the tray was shielded by 15 cm. of lead. Fourfold coincidences were recorded both with and without a lead roof 1 cm. thick (supported by 1 cm. of iron) about 30 cm. above the top of the lead shield. The unshielded counters were placed at a sufficient distance from the shielded tray so as not to be affected by the roof. A considerable change of the rate of fourfold coincidences in the presence of the roof was noticed. The actual rates found are given in Table 1.

Table 1. Fourfold coincidences, rate per hour

| | |
|---|---|
| With roof | 0·263 ± 0·037 |
| No roof | 0·474 ± 0·053 |
| Difference | 0·211 ± 0·064 |

The above experiment was repeated and confirmed by us in Dublin. Threefold coincidences were recorded between two unshielded trays each of 750 cm.² area and a shielded tray of 1,500 cm.² area. The arrangement of the shielded tray and the roof are illustrated in the accompanying sketch. The roof was supported by 4 in. of wood resting on brick supports. The supports and the wood were left in position throughout the series. Measurements were carried out with various absorbers $A$ placed on top of the wood. The results obtained are given in Table 2.



Shielded tray and roof

Table 2

| Absorber $A$ | No. of coincidences | Rate per hour |
|---|---|---|
| No absorber | 325 | 3·32 ± 0·18 |
| 20 gm./cm.² brick | 231 | 3·33 ± 0·20 |
| 1·7 cm. lead | 380 | 2·53 ± 0·13 |

We see from Tables 1 and 2 that a thin lead roof reduces the number of penetrating extensive showers recorded, while a mass-equivalent brick roof shows no noticeable effect.

The above experiment can be interpreted, in our opinion, as follows:

(1) The penetrating particles in air showers are produced locally in the first few centimetres of lead.

(2) The penetrating particles are highly unstable and have a considerable chance of decay along the 50-cm. gap between roof and absorber. An apparent life of the order of $10^{-9}$ sec. is to be expected.

(3) While the thin lead roof shows a considerable effect, no noticeable effect is shown by a mass-equivalent brick roof. It must be concluded that the primaries of the penetrating particles are strongly absorbed in lead but not in the mass-equivalent of brick. This makes it virtually certain that the primaries of the penetrating particles are either electrons or photons or both.

(4) It may be added that this experimental evidence is incompatible with the view that the penetrating particles are produced by nucleons; nucleons would show similar effects in lead and brick roofs. Thus the present experiment further supports the view that the *local* penetrating showers which are produced by nucleons are qualitatively different from the extensive penetrating showers.

The above conclusions, with the exception of (2), were put forward previously by Jánossy and Broadbent[3] as a result of a detailed analysis of shower data.

It should be noted that conclusion (1) stands independently of whether (2) is admitted or not. Though we think it likely that the actual decrease of the shower-rate is caused by decay, this interpretation is not essential for the arguments below; if the decrease were to be explained by any other mechanism (for example, scattering in the roof), it would still be necessary to maintain that the penetrating particles are produced by photons in a thin layer of lead.

## Z Dependence of the Production of Penetrating Particles

In discussing the nature of the penetrating particles in air showers, we may recall the experiments carried out by Cocconi and Festa[3], Mura, Salvini and Tagliaferri[4], and Chowdhuri[5]. Extensive showers were recorded in these experiments by counter trays all except one of which were unshielded. The shielded tray was covered alternately with lead only and with lead under an iron shield. As was pointed out by

Ferretti, the number of penetrating events recorded should be proportional to

$$k = \Phi \text{ (prod)} / \Phi \text{ (abs)}, \qquad (1)$$

where $\Phi$ (prod) is the cross-section for the production of penetrating particles in the top layer of the shield, and $\Phi$ (abs) is the cross-section for the absorption of the primaries giving rise to penetrating agents. As shown above, the penetrating agents are produced either by electrons or photons; thus

$$\Phi \text{ (abs)} \sim Z^2 \text{ per atom.}$$

The comparison of lead and iron absorbers has shown experimentally that $\Phi$ (prod) / $\Phi$ (abs) is independent of $Z$. Thus

$$\Phi \text{ (prod)} \sim Z^2. \qquad (2)$$

Furthermore, it is found that $k \sim 1/50$, and therefore

$$\Phi \text{ (prod)} \sim \frac{\Phi \text{ (rad)}}{50}. \qquad (3)$$

where $\Phi$ (rad) is the 'radiative cross-section'; that is, either the cross-section for *Bremstrahlung* or pair production.

Equations (2) and (3) are most remarkable. They show clearly that the penetrating radiation must be emitted in collisions in the Coulomb field of the nucleus; thus the conclusion can scarcely be escaped that the penetrating particles are either of the two following types:

(*a*) Particles somewhat heavier than electrons, created by photons by pair production.

(*b*) Neutral particles emitted by electrons as a kind of collision radiation.

If the latter hypothesis were assumed, it would be necessary to ascribe to the electron a charge which is the source of the neutral field. The neutral quantum could then be emitted by the electron accelerated in the Coulomb field. Hypothesis (*b*) is, however, rendered unlikely in view of the experiments of Broadbent and Jánossy, where penetrating agents are found to discharge frequently two covered trays (*m*) and (*b*) on top of each other.

We are therefore left with hypothesis (*a*) that penetrating particles in air showers are largely 'heavy electrons' or $\lambda$-mesons produced presumably by photons. We may add that the heavy electrons observed must have energies exceeding 200 MeV. as they are capable of penetrating 15 cm. of lead. If their rest energy is of the order of a few MeV., then the *proper life* is estimated to be of the order of $\tau \sim 10^{-11}$ sec.

This short life fully accounts for the absence of cloud chamber evidence (see, for example, Fretter[6]). A track which might possibly be a case of a decaying heavy electron is found in the left-hand bottom corner of a photograph of a penetrating air shower given by Jánossy, Rochester and Broadbent[7]. The particles penetrating a lead plate seen on the same photograph might very well be examples of heavy electrons.

The supposed short life of the heavy electrons throws more light on the analysis by Auger and co-workers[1]. This analysis shows that extensive showers when penetrating lead absorbers behave essentially differently from what is to be expected from cascades. On the other hand, the behaviour of extensive air showers in the atmosphere can be accounted for in terms of the cascade theory, as shown, for example, by Cocconi, Loverdo and Tongiorgi[8]. This discrepancy can be explained in terms of the instability of the heavy electron. The heavy electrons play an important part only in dense absorbers.

## Estimate of the Mass of the Heavy Electron

The experiments described above, together with those reported earlier[1,2], seem to show conclusively that at least an appreciable fraction of the penetrating particles in air showers are different in nature from particles observed hitherto. The conclusion that these new particles are, in fact, heavy electrons must be taken only as a conjecture, supported by general theoretical arguments. It seems, however, worth while to show that the assumption of a heavy electron of suitable mass does not lead to contradictions.

In particular, it follows from general arguments that the ratio between the cross-section for production of heavy pairs and the cross-section for collision radiation of a heavy electron must be very nearly the same as the ratio of the corresponding cross-sections for ordinary electrons; we show in the following that the observed effects are compatible with this general assumption.

The cross-section $\Phi$ (prod) of equation (1) is the average cross-section for the production of a heavy pair per incident electron. We derive the actual probability for the production of a heavy pair in the following way.

An electron or photon of energy $E$ incident on the absorber gives rise to cascades, and the total photon path-length of photons with energy exceeding $E'$ is

$$t\,(E, E') = 0{\cdot}572\ E/E' \text{ cascade units.}$$

Assuming that the number of photons is 1·5 times the number of electrons in the shower, we have for the total photon path associated with one electron

$$2{\cdot}5\ t\,(E, E') = 1{\cdot}43\ E/E'.$$

The energy spectrum of the air shower can be represented by

$$dS\,(E) \sim \frac{E_c\,dE}{(E + E_c)^3} \quad E_c = 100 \text{ MeV.} \qquad (4)$$

(Mitra and Rosser, in the press; reported at the Bristol Symposium).

Thus the total path-length per incident electron in cascade units is

$$T\,(E') = \frac{1{\cdot}43}{E'} \int_{E'}^{E_1} \frac{E\ E_c\,dE}{(E + E_c)^3} =$$

$$\frac{1{\cdot}43\ E_c}{E'} \left\{ \log \frac{E_1 + E_c}{E' + E_c} - \frac{E_c\,(E_1 - E')}{E_1 + E_c} \right\} \qquad (5)$$

($E_1$ is the upper limit of the validity of (4)).

The mean free path of a photon for giving rise to an ordinary pair is 1·35 cascade units; thus the probability $P$ of a heavy pair being produced is about $0{\cdot}76\ T\,(E')\ K$, where $K \sim (m_e/m_h)^2$.

We have to consider the probability that a heavy electron discharges one of the shielded counters. The ionization loss in 15 cm. of lead (30 cascade units) is 200 MeV.; thus only heavy electrons with $E' >$ 200 MeV. need be considered. The probability of a heavy electron $E' > 200$ MeV. traversing the absorber of 30 cascade units is of the order of $\exp(-30\ K\ \alpha\,(E'))$, $30\ K$ being the thickness of the absorber in cascade units of the heavy electron; $\alpha\,(E')$ is a function derived from cascade theory, which has values somewhat less than unity for small energies and is decreasing for larger energies.

We have thus for the fraction $k$ of penetrating particles

$$k = 0{\cdot}76\ T\ (200 \text{ MeV.})\ K \exp(-30\ K\ \alpha\,(E')).$$

Now putting $k = 1/50$ (equ. 3), $K = 1/30$, $\alpha = 1$, the equation requires $T'(E') \sim 2{\cdot}0$. This value is reasonable; it is obtained from (5) by putting $E_1 \sim$ 6,000 MeV. Thus the experimental findings are roughly in accord with $K = 1/30$; that is, $m_h \sim 6m_e$. The above consideration is very rough; but it seems to show that the heavy electron hypothesis is not incapable of accounting for the experimental findings.

We are greatly indebted to Prof. W. Heitler for detailed discussions, and we are also indebted to Dr. T. Nevin for help during the experiments.

*Note added in proof.* After submitting this communication a photograph purporting to be that of a particle of mass $10\,m_e$ has been reported by Cowan (*Science*, November 12, 1948).


Auger, Daudin, Fréon and Maze, *C.R. Acad. Sci. Paris*, **226**, 169 (1948).

Broadbent and Jánossy, *Proc. Roy. Soc.*, A, **193**, 364 (1948).

Cocconi and Festa, private communication.

Mura, Salvini and Tagliaferri, *Nature*, **159**, 367 (1947); *Atti. Acad. Linc.*, **2**, 437 (1947).

Chowdhuri, *Nature*, **161**, 680 (1948).

Fretter, *Phys. Rev.*, **73**, 41 (1941).

Jánossy, Rochester and Broadbent, *Nature*, **155**, 142 (1945).

Cocconi, Loverdo and Tongiorgi, *Phys. Rev.*, **70**, 852 (1946); *Rend. Cont. Sci.*, **77**, 1 (1943).


# SIMULTANEOUS MEASUREMENT OF THE OPTICAL CONSTANTS OF METALS OVER A WIDE WAVE-LENGTH RANGE

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THE optical constants of metals can be calculated from a knowledge of the ellipse of vibration which results from the reflexion of plane polarized light usually at an azimuth of 45° by a plane metallic surface. In the present method, this ellipse is determined by finding the ratio of the major and minor axes and the orientation of the major axis to the plane of incidence. It differs, however, from other methods using this principle in that the data from which the ellipse is obtained are produced on a photographic plate in the form of a thin vertical strip of variable intensity for each wave-length. A continuous source and a dispersing prism enable a record to be obtained simultaneously for the whole of the spectrum-range required.

The essentials of the optical system are shown in Fig. 1. The reflected elliptically polarized light passes through the rotator $T$, which consists of two prisms of right- and left-handed quartz in optical contact. Above the central plane the ellipse will be rotated clockwise; below, counter-clockwise. Fig. 2 indicates the relative orientations of the ellipse in the light emerging from the rotator. If the analysing

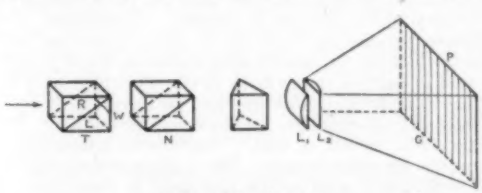
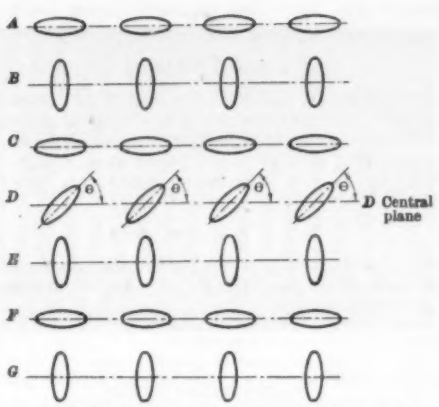



Fig. 1. Optical system




$A$, $C$, $F$, minima; $B$, $E$, $G$, maxima; $BC = AC$

Fig. 2. Relative orientations of the ellipse

nicol $N$ is adjusted for plane polarized light, the vibration direction of which is vertical, then in the positions $ACF$ the intensity will be a minimum, and in positions $BEG$ a maximum. The square root of the ratio of these intensities gives the ratio of the axes. $DD$ is the central plane, so that the orientation of the ellipse is given by

$$\theta = \frac{CD}{CF} \times 180°.$$

A fiducial line consisting of a very fine wire $W$ is placed immediately after the rotator and adjusted to be in the central plane. A plano-cylindrical lens $L_1$ produces at its conjugate focus $P$ an image of the pattern of Fig. 2, modified by the analyser, and of the fiducial line, magnified in the vertical plane only. A second plano-cylindrical lens $L_2$ converges the light horizontally into a vertical strip of variable intensity in its focal plane $P$. Using white light and a prism, a spectrum crossed by a system of dark and bright bands together with the horizontal fiducial line is obtained on a photographic plate placed at $P$. By removing the rotator and analyser, which are mounted together, and placing in position a triangular aperture with base horizontal and its plane coincident with the fiducial line $W$, an exposure of graded intensity is obtained. In front of the photographic plate $P$, which can be moved horizontally in its own plane, a grid $G$ is placed, consisting of alternate opaque and transparent strips. This enables the crossed spectrum and the comparison spectrum of graded intensity to be obtained, adjacent strips being of the same wave-length.

Fig. 3 shows the pattern obtained with aluminium, the exposure time for each spectrum, taken consecutively, being 40 sec. Microphotometric comparison of the maxima and minima against the adjacent graded intensity enables the ratio of the axes to be determined, while the distance between the fiducial line and the various maxima and minima gives the orientation of the ellipse. Since the time involved in obtaining the data for a wide wave-length region is so short, the method is clearly advantageous in that deterioration or change of the surface while observations are being made is avoided. So far as we are aware, all existing methods of measuring the optical constants of metals require the use of monochromatic light, making the determination of a dispersion curve a lengthy process.

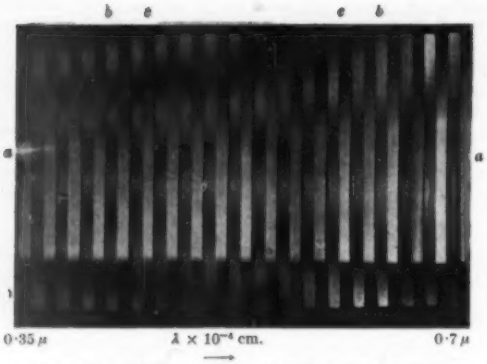



Fig. 3. (*a*) Fiducial line; (*b*) vertical bands of variable intensity; (*c*) adjacent graded intensity

Experiments have so far been carried out in the wave-length range 0·35–0·7 μ with gold and aluminium specimens of known dispersion (measured on the senior author's photo-electric apparatus[1]), and good agreement was obtained. The estimated accuracy is about 2 per cent, but improvements now being made are expected to increase the accuracy and reduce the exposure time.

One of us (B. G. C.) is indebted to the Department of Scientific and Industrial Research for the award of a maintenance grant.

[1] Bor, *Nature*, **139**, 716 (1937). Bor, Hobson and Wood, *Proc. Phys. Soc.*, **51**, 932 (1939).

## GROUND SUBSTANCE OF THE MESENCHYME AND HYALURONIDASE

A CONFERENCE devoted to the "Ground Substance of the Mesenchyme and Hyaluronidase" was organised by Dr. F. Duran-Reynals with the co-operation of Dr. E. D. Goldsmith and was held during December 3–4 under the sponsorship of the New York Academy of Sciences.

The programme concerned itself with all phases of current research pertaining to acid mucopolysaccharides and hyaluronidase, the most important of the group of substances known as spreading factors. Histochemical, electron microscope, biochemical, bacteriological, endocrinological and clinical findings were reported.

Hyaluronidase is widely distributed in Nature. It is found in male germ cells, in pathogenic bacteria, such as streptococci and pneumococci, in insects, in fishes, and in the poison glands of several venomous reptiles. Although produced by such diverse organisms, the function of the enzyme is the same in all cases; but the results are totally different. The function of hyaluronidase is to attack the cementing mucoid substance of the connective tissue. By attacking this cementing substance, the enzyme 'dissolves' it and opens the way for any material which may penetrate the body with it.

Thus, the spreading factor associated with the male germ cells dissolves the cementing material surrounding the female germ cells and makes fertilization possible. (The adhesive quality of mucopolysaccharides of ovarian follicular fluid clumps the granulosa cells around the discharged ovum until acted upon by hyaluronidase from the sperm.) When the factor comes from a bacterium it facilitates invasive infection, and when hyaluronidase is injected with a therapeutic agent, it speeds and enhances the action of such agents.

The study of the action of the enzyme on the cement substance has served to explain an important factor in the mechanism of infection, namely, spreading in the organism of poisons or infectious agents. Equally it has provided a tool for the clinician, since it promotes the spreading of therapeutic substances in the organism. Infections may thus be fought with their own weapons.

The following papers dealing with more specific aspects were read at the conference.

The enhancement of the capacities for growth and invasion of a mouse transplantable squamous cell carcinoma by the local injection of hyaluronidase from testis (W. L. Simpson, Detroit Institute of Cancer Research).

The facilitation of absorption of subcutaneously injected lactate–sodium-glucose solutions with a diminution in pain. It should prove to be extremely useful in hypodermoclysis (C. L. Burket and P. Gyorgy, University of Pennsylvania).

Hyaluronidase enhances the penetration as well as the spreading of drugs. Further, it exhibits very low toxicity (J. Seifter, Wyeth Institute of Applied Biochemistry).

Hyaluronidase reported to be effective in the spreading of the anæsthetic action of local anæsthetics. Certain difficulties encountered in nerve block techniques in regions like the mandible may be overcome by the addition of hyaluronidase to the procaine–epinephrine mixture (C. H. Kirby, J. P. Looby and J. E. Ekenhoff, School of Medicine and Dentistry, University of Pennsylvania).

Dr. D. H. Sprunt (University of Tennessee) and Dr. M. Lurie (Henry Phipps Institute) emphasized the importance of the connective tissue ground-plasm in infection (tuberculosis, D. Lurie). Female sex hormone increases the turgidity of the connective tissue elements and reduces capillary fragility. Œstrogens retard the progress of tuberculosis, chiefly by reducing the permeability of the connective tissue, whereas gonadotrophin enhances the progress of the disease, primarily, by increasing the permeability. It is noteworthy that some years ago Thomas and Duran-Reynals accelerated the progress of tuberculosis with hyaluronidase.

Additional findings by Drs. F. Duran-Reynals, G. Van Wagenen, H. Bunting and J. Opsahl (Yale University School of Medicine) pertaining to the relationship between the œstrogens, adreno-cortical hormone and the ground substance and hyaluronidase were reported.

Drs. C. Ragan and K. Meyer (College of Physicians and Surgeons, Columbia University), in their report on the possible connexion between hyaluronidase and rheumatic diseases, disclosed that the pathogenesis of the rheumatic diseases is obscure. Apparently, the disease process is localized in the connective and particularly in the interfibrillar material, which is composed in part of one or both of the mucopolysaccharides—chondroitin sulphuric acid and hyaluronic acid. Many micro-organisms produce hyaluronidase; but only two, Group *A* and *C* hæmolytic streptococci, produce hyaluronic acid. The highest concentration of hyaluronic acid in the mammal is found in the synovial fluid (in the joint). In normal human joint

fluid the hyaluronic acid exists in a highly polymerized form; in rheumatoid arthritis, the hyaluronic acid is depolymerized, and the extent of depolymerization varies with the activity of the disease process.

Dr. M. C. Chang and Dr. N. T. Werthessen (Worcester Foundation for Experimental Biology) took issue with the conclusions of Dr. Raphael Kurzrock to the effect that hyaluronidase is a valuable adjunct in the treatment of infertility. Dr. Chang and Dr. Werthessen attributed Dr. Kurzrock's success to his excellent timing in determining the date of ovulation.

The conference closed on the note that the spreading substances and ground-plasm are of great significance. Much remains to be ascertained; and a uniform system of units should be devised.

E. D. GOLDSMITH

## SCIENCE MASTERS' ASSOCIATION

### ANNUAL MEETING

THE forty-sixth annual meeting of the Science Masters' Association was held during January 4–7 in London, at the Royal College of Science. Prof. F. R. Winton, University College, London, in the presidential address on "Specialization", suggested reasons for the undue specialization of school science, contending that boys are driven by a sense of insecurity into scientific studies in their search for truth, but in these studies they seldom meet with experience in the selection and recognition of the vital factors in a problem; and, further, one of the most important approaches, the statistical method, is neglected. Turning to a more detailed consideration of biology teaching, Prof. Winton criticized its subject-matter as being too often narrow and unrelated to human experience; he made a plea for more experimental work in human physiology, and proposed that reform might be brought about through a review of school courses by joint action of the Science Masters' Association and the Biological Council, with medical and psychological representatives.

On the subject of "Phase Contrast Microscopy and the Study of the Living Cell", Dr. Arthur Hughes, after an admirably simple account of the underlying principles, explained how this new technique has made possible the direct study of living cells in tissue cultures. Remarkable results, such as the identification of chromosomes in the resting stage and the formation of tetraploid nuclei, were illustrated by Dr. Hughes' own film of cell division in the spleen cells of the mouse.

In a lecture on "Why Schools should use M.K.S. Electrical Units", Prof. G. H. Rawcliffe pointed out that there is no justification for the present complexity of electrical units. This complexity arose because those who first suggested the units did not realize that the systems involved the permeability and the permittivity of air in addition to the centimetre, gram and second. The simplest unified system is the Metre–Kilogram–Second system, which erects the volt, the ampere and the units dependent on them into an absolute system; this has the advantage of being the system that electrical engineers use, and prevents the confusion between $B$ and $H$ in magnetism and that between $D$ and $E$ in electrostatics.

Sir Charles Goodeve discussed the "Making of Iron and Steel". He referred to the huge amounts of ironstone, coke, limestone and other raw materials used yearly for this purpose, and the selection and control of these by scientific methods. But the human intake which parallels this often lacks preparation, not only in knowledge of the elementary principles of the industry, but also in knowledge of the extremely wide range of trades, crafts and skills that the industry needs to keep it in operation.

The lecture on "The Perception of Light and Colour", by Dr. W. D. Wright, was illustrated by a wealth of demonstrations. Simple experiments were described in which the sensitivity of the eye to light could be compared under various conditions, and the phenomena used, if required, to introduce the idea both of the adaptation of the organism to its environment in biology and the quantum nature of light in physics, as well as the practical problems of vision involved in night flying, driving at night, etc. A method of approach was suggested by which instruction about colour by the art master might be co-ordinated with that by the science master.

Prof. E. D. Hughes, of University College, London, introduced his lecture on "Recent Theories of Organic Chemistry" with a general survey of the application of modern valency theory to problems relating to the structure and reactions of typical groups of organic compounds. Ideas on partial ionic character and resonance hybrids provided explanations of apparently contradictory results of hydrolysis of esters and the reactions of carbonyl and carboxylic groups.

Dr. B. Wheeler Robinson, superintendent of the Physics Division of the National Physical Laboratory, in dealing with "Physics at the N.P.L.", explained how this Laboratory has responsibility for the maintenance of physical standards, for special tests and investigations for the benefit of industry, and for original research arising therefrom. The Physics Division, one of ten divisions which comprise the Laboratory, deals mainly with radiology, heat measurements and acoustics. The measurement of the temperature of molten steel and the thermal conductivity of a building panel were described in more detail, and Dr. Robinson showed how the methods in practice differ from the text-book accounts of them.

"English in the Science Course" formed the subject of a lecture by Dr. D. C. Collins. He pointed out that style is not extraneous ornament; it comes from clear thinking. Words are important to the scientific man as a means by which he explains to 'everyman' the scientific picture of the material world. The difficulty of using words, which is a modern phenomenon, is perhaps due to the decay of the study of the classics, which, *inter alia*, gave a training in the writing of English, and modern courses in English have not completely taken the place of the study of the classics. Dr. Collins suggested possible ways of remedying the deficiency and developing the required skill of writing.

Dr. E. A. R. Ennion described various methods in use at Flatford Mill Field Centre, where he is warden, for the training of students in field-work of all kinds (natural history, geography, local history and rural surveys) and for the initiation and promotion of amateur research. Student groups covered comprise teachers themselves, training college and fifth or sixth form school classes coming with or without teachers and either individually or as corporate parties. The basic assumption was that there is a place for properly conducted amateur research. It is quite feasible for students to acquire the necessary com-

petence provided they are intelligently taught to observe and investigate rather than to listen and collect.

Other meetings included a lecture demonstration by the Gramophone Company on "Sound Recording and Reproduction"; different types of recording apparatus were dealt with and some of the difficulties met with were discussed. A discussion on "The Social Sciences in the Grammar School" was opened by Mr. K. G. Collier, of Lancing College. Points covered were the social sciences as the science of human nature and human society; the emergence of a synthesis of views in this field; the potential educational value of the social sciences for integrating the sixth form curriculum, showing the nature and potentialities of scientific method to arts students and conveying to science students the special adaptation and limitations of scientific method in the human sphere.

The exhibitions of apparatus and books attracted much attention, and the members' exhibition revealed once again this year the considerable thought and ingenuity which are being brought to bear on the teaching of science in secondary schools in Great Britain. The apparatus due to Mr. F. A. Meier (Institute of Education, University of London) formed the major contribution—more than forty items, ranging over many branches of physics; some, like the apparatus for making spiral springs, appealed on account of usefulness; others, like the home-made biprism and Fresnel mirrors, were remarkable for their simplicity; but all reflected the genius of their author.

## DEFINITION OF THE PLIOCENE–PLEISTOCENE BOUNDARY

THE question of defining the Pliocene – Pleistocene boundary has become important in recent years, because the practices of different geologists have varied to such an extent that deposits described in one publication as Lower Pleistocene may, in fact, be of the same age as deposits elsewhere called Upper Pliocene. A similar problem is presented to geologists and palæontologists at the boundaries of other geological systems; but the problem of where best to draw a boundary between Pliocene and Pleistocene is one which concerns also prehistorians and anthropologists.

At the eighteenth session of the International Geological Congress, one section devoted itself to the discussion of this topic. Opinions of geologists, palæontologists and prehistorians from many different countries were expressed, and there appeared to be a wider measure of general agreement than had been expected. While these discussions were taking place, the Council of the Congress appointed a temporary commission to advise on the question. The following served as members of the Commission: Prof. Kirk Bryan (United States), Prof. G. Dubois (France), Dr. A. T. Hopwood (Great Britain), Prof. W. B. R. King (Great Britain), Dr. L. S. B. Leakey (Kenya), Prof. C. I. Migliorini (Italy), Dr. K. Milthers (Denmark), Dr. Hallam L. Movius, jun. (United States), Dr. K. P. Oakley (Great Britain), Dr. L. L. Ray (United States), Prof. I. M. van der Vlerk (Netherlands), Dr. D. N. Wadia (India), Prof. D. M. S. Watson (Great Britain), Mr. E. J. Wayland (Bechuanaland), Prof. F. E. Zeuner (Great Britain).

At the conclusion of the meetings, the Council of the Congress accepted the recommendations of the Commission, which were as follows:

(1) The Commission considers that it is necessary to select a type-area where the Pliocene – Pleistocene (Tertiary – Quaternary) boundary can be drawn in accordance with stratigraphical principles.

(2) The Commission considers that the Pliocene – Pleistocene boundary should be based on changes in marine faunas, since this is the classic method of grouping fossiliferous strata. The classic area of marine sedimentation in Italy is regarded as the area where this principle can be implemented best. It is here, too, that terrestrial [Continental] equivalents of the marine faunas under consideration can be determined.

(3) The Commission recommends that, in order to eliminate existing ambiguities, the Lower Pleistocene should include as its basal member in the type-area the Calabrian formation (marine) together with its terrestrial [Continental] equivalent, the Villafranchian.

(4) The Commission notes that, according to evidence given, this usage would place the boundary at the horizon of the first indications of climatic deterioration in the Italian Neogene succession.

From the papers read in the section of the Congress devoted to this topic, which are being summarized in the *Geological Magazine*, it is clear that this definition has wide application.

The following table indicates what we consider to be its implications in parts of Europe.

| | | Italy | Netherlands* | | East Anglia* | Human culture |
|---|---|---|---|---|---|---|
| | | | *continental* | *marine* | | |
| Lower Pleistocene | | Sicilian (*sensu stricto*) | Lower Brabantian | Icenian | Weybourne Crag | Abbevillian |
| | | | Tiglian | | Norwich Crag | |
| | Villafranchian | Calabrian I, II | Pretiglian | Amstelian | Upper part of Red Crag (Butleyan) | Pre-Abbevillian ? |
| Pliocene | | Uppermost part of Astian | Reuverian | Poederlian | Middle part of Red Crag (Newbournian) | |

* Based on a paper submitted by Prof. I. M. van der Vlerk (Netherlands).

This table is based on studies of the faunas of shallow-water marine deposits, and of their continental equivalents where known. The Villafranchian is characterized by a fauna which includes *Elephas*, *Equus* and advanced bovines. This fauna is widespread and has been used for correlating deposits of the same age in different continents. Thus, the apparent equivalents of the Villafranchian are as follows: in Africa, the Kageran beds (with Pre-Abbevillian pebble-tools); in India, the Pinjor stage of the Upper Siwaliks; in China, the Nihowan stage; in Java, the Djetis beds; and in the Central Plains of North America, the Blanco beds.

While it is evident that the Calabrian stage corresponds with the onset of cool conditions in the type-area, correlation with the glacial sequence in the Alps is not yet agreed. Thus, Dr. R. Selli and Dr. G. Ruggieri, in their paper submitted to the Congress, on the Plio-Pleistocene stratigraphy in Emilia (northern Italy), claim that the Calabrian stages I and II are probable equivalents of the Günz and Günz–Mindel stages of the Alpine sequence, and that the Sicilian (*sensu stricto*) corresponds with the Mindel glaciation. On the other hand, a more widely held view is that the drop from the Sicilian high sea-level was brought about by the first major glaciation (Günz). On this latter reading of the data, the basal or Villafranchian division of the Lower Pleistocene is in large part older than the first important growth of ice-caps, and corresponds with the climatic deterioration which was marked in the Alps, for example, by the Donau phases of glacier-growth. Judging from the great thickness of deposits accumulated during the Villafranchian stage, it was of considerable duration.

W. B. R. King
K. P. Oakley

## LOCUST BEHAVIOUR AND AIRCRAFT SPRAYING

AERIAL spraying has for long seemed to offer the only means of attacking swarms of winged locusts, and an article in *Nature* of March 6, 1948, outlined the history of the latest attempt to develop this method. "We set out", wrote Dr. D. L. Gunn in that article, "systematically to find whether aircraft methods are applicable to locust destruction and to work out where and when they may compete in effectiveness and in cost with other methods"—something that had not been done before. The full story of the attempt is now appearing; the two present publications*† show how formidable the task was and indicate the very remarkable level of team-work achieved among the entomologists, physicists, chemists, meteorologists and airmen who were involved.

The object of the behaviour studies on the desert locust in Kenya* was to discover what governed the time a swarm remained on its roosting site before flying away in the morning, since it was against roosting swarms that spraying operations were then contemplated. Swarms were watched on seventeen mornings, with simultaneous intensive recording of air temperature, humidity, locust body-temperature, radiation and wind. The start of 'stream-away', when the locusts moved off *en masse*, was usually quite sudden. Among all the factors measured, only the air temperature showed some consistency at this time on different days (*Nature*, **156**, 628; 1945). Apart from its possible practical value, this finding raises interesting physiological and behavioural questions, which are discussed. In seeking for an explanation for the variations in the air temperature at stream-away, a correlation was found between that temperature and the previous day's maximum temperature. The latter is regarded as a measure of the general temperature conditioning to which the insects had been exposed, and it is suggested that a form of physiological temperature adaptation may be involved.

The authors succeeded in tracing the roost-to-roost displacements of a single swarm for eighteen consecutive days. The swarm showed an over-all trend northwards, but zig-zagged a good deal. The displacements of a second swarm were roughly consistent with its being carried by the wind. This type of information on insect migration is very rare, and does not support the idea that migrants drive on undeviatingly towards a hypothetical goal.

The spraying trials against roosting red locusts in Tanganyika† demonstrated the inferiority, for this purpose, of the traditional method of trying to fly low enough during spraying to minimize the spray-drifting action of the wind, as compared with the method, new to insecticide work, of flying at a height calculated to use the existing wind to give the desired spray pattern on the ground. 20 per cent dinitro-*ortho*-cresol (DNOC) solution in oil proved so effective, with complete mortality at about one gallon per acre, that it was used in an intensive series of practical operations, 3,700 gallons being sprayed on a total of 3,335 acres. The authors are cautious; but it appears that their operations may well have averted a serious outbreak of the red locust.

By unexpected good fortune, the swarms were virtually stationary during the campaign. The work would have been very much more difficult had they migrated every day. After giving some estimates of costs, the authors suggest that roosting swarms might be tackled more economically with ground machinery, but that aircraft might be more efficient against flying swarms than against roosting ones.

Both publications contain a mass of factual material on subjects which have had little such foundation hitherto, including detailed estimates of locust numbers and densities made by photographic and other methods.

*"Behaviour of the Desert Locust (*Schistocerca gregaria* Forskål) in Kenya in relation to Aircraft Spraying." By Dr. D. L. Gunn, F/O. F. C. Perry, F/Lt. W. G. Seymour, F/Lt. T. M. Telford, AC/2 E. N. Wright and D. Yeo. (Anti-Locust Bulletin 3.) Pp. 70+8 plates. (London: Anti-Locust Research Centre, British Museum (Natural History), 1948.) 8*s*.

†"Locust Control by Aircraft in Tanganyika: an Experimental Campaign with BHC (Benzene Hexachloride) and DNOC (Dinitro-*ortho*-cresol) Solutions against Adult Red Locust, *Nomadacris septemfasciata* (Serv.), in an Outbreak Area, the Rukwa Valley, from August to November, 1947." By Dr. D. L. Gunn, H. A. F. Lea, D. H. Botha, S. Callaway, J. R. Clackson, A. Immelman, J. J. Taljaard and J. Ward. Pp. 153+10 plates. (London: Anti-Locust Research Centre, British Museum (Natural History); Pretoria: Locust Control and Research Centre, Department of Agriculture, 1948.) n.p.

## FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

### Monday, January 31

Institution of the Rubber Industry, Leicester Section (at the College of Art and Technology, Leicester), at 7 p.m.—Dr. C. M. Blow: "Latex".

Institution of Electrical Engineers, Cambridge Radio Group (joint meeting with the Cambridge University Wireless Society, at the Cavendish Laboratory, Cambridge), at 8.15 p.m.—Mr. L. A. Moxon: "Noise and Band Width".

### Tuesday, February 1

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. R. Ogilvie Buchanan: "Some Geographical Aspects of the Economic Development of New Zealand".* (Further Lecture on February 8.)

University of London (in the Department of Civil, Mechanical and Chemical Engineering, King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr. A. H. Willis: "The Mechanical Properties of Matter".* (Further Lecture on February 8.)

### Wednesday, February 2

University of London (at Bedford College for Women, Regent's Park, London, N.W.1), at 5.15 p.m.—Sir George Stapledon, F.R.S.: "The Ecology of Food Production".*

University of London (in the Senate House, Malet Street, London, W.C.1), at 5.30 p.m.—Sir John Cockcroft, F.R.S.: "The Application of Atomic Piles in Nuclear Physics".* (Further Lectures on February 9 and February 16.)

ROYAL MICROSCOPICAL SOCIETY, BIOLOGICAL SECTION (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 6 p.m.—Mr. O. D. Standen: "Some Biological Aspects of Experimental Schistosomiasis".

MANCHESTER METALLURGICAL SOCIETY (joint meeting with the IRON AND STEEL INSTITUTE, at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. Glen: "Precipitation Hardening Effects in Relation to High Temperature Testing".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the PORTSMOUTH AND DISTRICT CHEMICAL SOCIETY, in the Portsmouth Municipal College, Portsmouth), at 7 p.m.—Dr. L. H. Lampitt: "Food Science in Evolution".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Scientific Papers.

### Thursday, February 3

ROYAL SOCIETY OF ARTS, INDIA, PAKISTAN AND BURMA SECTION (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. W. A. M. Walker: "The Growth of the Jute Industry in India and Pakistan".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS, SUPPLY SECTION (joint meeting with the INSTITUTION OF CIVIL ENGINEERS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. Headland: "Tidal Power and the Severn Barrage". (To be repeated on Monday, February 7, at the James Watt Memorial Institute, Great Charles Street, Birmingham, at 6 p.m.; on Monday, February 14, at the Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.; on Monday, March 7, at the Liverpool Royal Institution, Colquitt Street, Liverpool, at 6.30 p.m.; on Wednesday, May 4, at the Harris Institute, Preston, at 6.45 p.m.; and on Wednesday, May 18, at the Wedgwood Café, Albert Road, Bournemouth, at 6.30 p.m.)

UNIVERSITY OF LONDON (in the Architecture Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. J. R. N. Stone: "The Role of Measurement in Economics" (Newmarch Lectures).* (Further Lectures on February 10, February 17 and February 24.)

INSTITUTION OF CIVIL ENGINEERS, NORTH-WESTERN ASSOCIATION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. W. E. De Courcy Hamilton: "Economic Survey as applied to Civil Engineering".

BRITISH INSTITUTION OF RADIO ENGINEERS, NORTH-WESTERN SECTION (in the Reynolds Hall, College of Technology, Manchester), at 6.45 p.m.—Messrs. A. Levin, Harley and Davidson: "The Design Characteristics of Marine Radar Equipment".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Mr. R. P. Bell, F.R.S.: Johannes Nicholas Bronsted Memorial Lecture.

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 7.15 p.m.—Mr. W. Harrison and Mr. H. Hewitt: "Artificial Daylight—a new Colour Matching Unit".

### Friday, February 4

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (at the Town Hall, Manchester), at 2.15 p.m.—Annual General Meeting; Dr. F. A. Freeth, F.R.S.: "The Place of Heterogeneous Equilibrium in Chemical Engineering".

PHYSICAL SOCIETY (in the Physics Department, University College, Gower Street, London, W.C.1), at 5 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Edward Salisbury, F.R.S.: "Leaves".

### Saturday, February 5

BRITISH GLACIOLOGICAL SOCIETY (in the Department of Geography, Cambridge), at 8.15 p.m.—Dr. H. Godwin, F.R.S.: "Pollen Analysis of Glaciers in special relation to the Formation of Various Types of Glacier Bands".

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# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN PHYSICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (February 5).

RESEARCH ORGANISER IN EDUCATION, and an ORGANISER OF TEACHERS' LIBRARY AND INFORMATION SERVICE—The Registrar, University College, Leicester (February 5).

ASSISTANT in the Medical Department to be Sub-Editor of the *British Medical Bulletin*—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1 (February 5).

LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN MATHEMATICS—The Principal, Heriot-Watt College, Edinburgh (February 8).

PRINCIPAL SCIENTIFIC OFFICER to lead a team developing specialized techniques for investigating the physical and mechanical properties of irradiated and non-irradiated metals and alloys, a PRINCIPAL SCIENTIFIC OFFICER to lead a team developing laboratory-scale fabrication techniques and in testing methods applicable to rare metals, a PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER for work on general metallurgical problems of piles, a PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER for powder metallurgy, a SENIOR SCIENTIFIC OFFICER to lead a team developing radioactive tracer techniques applicable to metallurgical problems, a SENIOR SCIENTIFIC OFFICER to lead a team developing techniques for fabrication of rare metals, a SENIOR SCIENTIFIC OFFICER to lead a team developing and adapting techniques for the physical and mechanical testing of rare metals, a SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER to take charge of metallographic section, and an EXPERIMENTAL OFFICER for metallographic section, at the Atomic Energy Research Establishment, Harwell—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2394 (February 8).

MECHANICAL AND ELECTRICAL ENGINEER in the Prison Commission—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2371 (February 10).

ECONOMIC MINING GEOLOGIST to make a survey of the known mineral resources of Burma, GEOLOGISTS for the Geological Department, and an ECONOMIC STATISTICIAN to take charge of the Statistical Department under the National Planning Board—The First Secretary, Burmese Embassy, 19a Charles Street, London, W.1 (February 11).

POST-GRADUATE RESEARCH STUDENTSHIP IN VETERINARY PARASITOLOGY, and a RESEARCH ASSISTANT IN THE DEPARTMENT OF ZOOLOGY—The Registrar, The University, Liverpool (February 12).

LECTURER IN THE DEPARTMENT OF CHEMICAL PATHOLOGY—The Professor of Chemical Pathology, King's College Hospital, Denmark Hill, London, S.E.5 (February 12).

DISTRICT (FOREST) OFFICERS—The Secretary, Forestry Commission, 25 Savile Row, London, W.1 (February 15).

ASSISTANT LECTURER IN CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (February 24).

LECTURER (ungraded) IN FARM ANIMAL MEDICINE, a LECTURER (ungraded) IN VETERINARY PHYSIOLOGY, a LECTURER (ungraded) IN VETERINARY BIOCHEMISTRY, and an ASSISTANT LECTURER (Grade III) IN VETERINARY ANATOMY—The Registrar, The University, Liverpool (February 28).

BIOCHEMIST and a PHYSICAL CHEMIST for the Atlantic Fisheries Experimental Station, Halifax, Nova Scotia—The Executive Director, Fisheries Research Board of Canada, Department of Fisheries, Ottawa, Canada (March 1).

LECTURER IN PHYSICS in the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (March 1).

READERSHIP IN TAXONOMY in the Department of Botany at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 2).

HEAD OF THE DEPARTMENT OF AFRICAN STUDIES in the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (March 19).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY, PHYSICS or allied subjects—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

FOREST MENSURATION OFFICER, SILVICULTURISTS (one for northern temperate softwoods silviculture, one for genetics research in northern temperate softwoods, and one for indigenous forest ecology and silviculture), a FOREST ENTOMOLOGIST, a TIMBER TECHNOLOGIST specializing in kiln and chemical seasoning, and a TIMBER TECHNOLOGIST specializing in plywood and laminated construction, in the N.Z. State Forest Service—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (April 30).

TURNER AND NEWALL RESEARCH FELLOWSHIP IN ENGINEERING, INORGANIC CHEMISTRY, PHYSICS or an allied subject—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

SENIOR LECTURER (Grade I) in the Department of Physics—The Registrar, The University, Liverpool (May 1).

RESEARCH CHEMISTS to engage in research on coal tar at the Research Station, Gomersal, Yorkshire—The Director of Research, Coal Tar Research Association, 9 Harley Street, London, W.1.

TECHNICIAN (Grade III), having a pathological background, in the Department of Genetics—The Secretary, University College, Gower Street, London, W.C.1, quoting 'Genetics/1'.

BOTANIST (Plant Breeder) in the Department of Agriculture, Nyasaland—The Director of Recruitment, Colonial Service, Colonial Office, Great Smith Street, London, S.W.1.

TECHNICAL ASSISTANT (male or female) at the Medical Research Council's Radiobiological Research Unit, Harwell—The Director, Radiobiological Research Unit, Atomic Energy Research Establishment, Harwell, Didcot, Berks.

RESEARCH ENGINEER or PHYSICIST to carry out investigations on mechanical and electrical problems connected with the dyeing and finishing of textiles—The Research Manager, British Cotton and Wool Dyers' Association, 351 Lower Broughton Road, Salford 3.

TECHNICIAN (Grade B), with histological experience, in the Department of Surgery—The Secretary, Marischal College, Aberdeen.

MINERALOGICAL CHEMIST in the Geological Division of the Lands and Mines Department, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

LABORATORY TECHNICIAN as biochemical research technician in the Department of Dental Medicine—Prof. M. A. Rushton, Guy's Hospital Dental School, London Bridge, London, S.E.1.

ASSISTANT PROFESSOR who is an honours graduate in Mechanical Engineering, and LECTURERS (2) with honours degree in Mathematics, at the Royal Naval College, Greenwich—The Secretary, Admiralty (C.E. Branch 1), London, S.W.1.

RESEARCH TECHNICIAN for histological work and other duties—The Director, Department of Surgery, Guy's Hospital, London Bridge, London, S.E.1.

ADMINISTRATIVE DIRECTOR OF THE DEPARTMENT OF TECHNOLOGY, and an ADMINISTRATIVE ASSISTANT—The Secretary, City and Guilds of London Institute, Gresham College, Basinghall Street, London, E.C.2.

LABORATORY TECHNICIANS (one Senior and one Junior)—The Secretary, Northallerton Hospital Management Committee, Friarage Hospital, Northallerton, Yorks.